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# ECONOMIC INCENTIVES IN WATER QUALITY MANAGEMENT

Little (Arthur D.), Incorporated,
Cambridge, Massachusetts

December 1970

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FINAL REPORT – PHASE ONE

# ECONOMIC INCENTIVES IN WATER QUALITY MANAGEMENT

*submitted to*

**THE DEPARTMENT OF WATER RESOURCES**
**AGENCY OF ENVIRONMENTAL CONSERVATION**
**STATE OF VERMONT**

*by*

**ARTHUR D. LITTLE, INC.**
**CAMBRIDGE, MASSACHUSETTS**

**DECEMBER 1970**

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Arthur D. Little, Inc.

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## FINAL REPORT – PHASE I

# ECONOMIC INCENTIVES IN WATER QUALITY MANAGEMENT

## The Application of Effluent Charges in a Permit-Charge System

to the

DEPARTMENT OF WATER RESOURCES
AGENCY OF ENVIRONMENTAL CONSERVATION
STATE OF VERMONT

December 1970

(The research and consulting services reported herein were supported by a demonstration grant from the United States, Department of the Interior, Federal Water Quality Administration, Washington, D.C., in addition to the direct funding from the State of Vermont.)

Arthur D. Little, Inc.

## PREFACE

The work described in this report to the State of Vermont's Department of Water Resources deals with a tough problem – effluent charges – and a touchy issue – who pays what. The complexities involved in the problem and the controversies surrounding the issue make of the description neither easy reading nor easy writing. There are interlocking questions of law, economics, engineering, hydrology, finance and administration, and there are no simple answers. Nevertheless, with effluent charges drawing more and more attention as an element of water quality management, a report such as this, which begins to bring the several facets of the subject into perspective, was almost inevitable.

The research and consulting services for the Department during the past five months stem both from the immediate need to prepare for the administration of a new State law and from the opportunity that this effort affords for illuminating similar policy considerations elsewhere. The State of Vermont, through its practical experience with an effluent charge statute, is contributing significantly to knowledge about the possible wider application of effluent charges. The Federal Water Quality Administration, through demonstration grant assistance, is contributing to implementation of the Vermont statute. In its role as consultant, on a very challenging assignment, Arthur D. Little, Inc., has endeavored to respond to both "clients," the one directly and immediately and the other indirectly and for longer range purposes.

Assistance in this effort by many individuals in and out of government has been substantial. We acknowledge particularly the help of William Albert and John Hansen as well as others in the legislative and executive branches of government in the State of Vermont who have contributed background information and basic data on the many aspects of the task. We are grateful for the guidance provided by Edwin Johnson of the Federal Water Quality Administration staff. We particularly acknowledge the personal contributions to our own deliberations from Professor Irving Fox of the University of Wisconsin, who has directed extensive research on the subject of effluent charge systems, and to Messrs. Allen Kneese and Blair Bower of Resources for the Future, Inc., Washington, D.C., whose pioneering work in this field is so well-known.

The contributions of ADL staff participants – James Murphy, Robert Bohlig, David Hellstrom, Michael Mohr, Frederic March and Rufus Perkins – deserve special mention. We continue as a team in a consulting capacity to the State of Vermont.

John M. Wilkinson
Project Director

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# INTRODUCTION AND SUMMARY

## BACKGROUND

In the decade of the 1960s, increasing worldwide attention was directed toward the problem of water pollution. As the problem intensified, a variety of technical, administrative and institutional measures – all within the broad label of water-quality management – were applied toward its solution.

Chief among these measures, in the United States, were (i) federal and state planning and construction grants in aid of funding water treatment plants by local governments to reduce discharged wastes; (ii) improved techniques in wastewater processing and control equipment to reduce discharged wastes, applications of which by industry were variously induced by tax credits for such expenditures; and, less extensively, (iii) federal water-storage programs to augment streamflow, hence increase the capacity of streams to assimilate or dilute discharged wastes. The basic philosophy has been that responsibility for acceptable water quality rests primarily at the local community level, subject to meeting standards of stream quality set by States and approved by the federal government.

Despite these measures, the quality of water in many of this country's rivers and lakes has not been improved and in some has deteriorated. The General Accounting Office reported to the U.S. Congress in November, 1969, that after 12 years under grant programs for construction of more than 9,400 projects costing about $5.4 billion, benefits have not been as great as they could have been because of continued discharge of untreated or inadequately treated wastes into waterways.

The war on water pollution was waged pretty much on legal-administrative and fiscal-financial territory. The legal-administrative device of stream standards often had to recognize the realities of prior "beneficial" uses of streams as natural waste-disposal systems. The fiscal-financial device of grants, while a strong *financial* incentive, was inadequately supplied in amount, time and location relative to need and its effectiveness was eroded by inflation. At the same time, little attention was directed to *economic* incentives in water-quality management and to the measurement and wise use of the economically valuable waste-assimilative capacity of watercourses.

Early in the 1960s, research began on the conceptual design and rationale for an effluent fee or charge system. Stated in simplest form, such a pollution or effluent charge would be levied against a waste discharger on some basis to take into account both his direct on-site treatment costs and those indirect costs variously called off-site, downstream, external, social, or damage costs which do in fact result from degraded stream quality. The discharger would then have an economic incentive to correct his practices or adjust his processes and avoid the charge. Applied in its purist form, the system would also allow a town or industry to pay the fee and continue to discharge as before – the popularly-expressed "right to pollute" feature. If this were the discharger's choice, it would reflect his own economic judgment and decisions, not those of the "state," about the measures that could be taken by the firm to correct pollution. Generally speaking, the fee mechanism would tend to allocate a scarce resource – water – among competing users in the economically "best" way, or with state stream quality standards to be met (which presumably reflect all desired water uses), it would achieve such standards at lowest total cost to industry, towns, fishermen, boaters, or anyone else who uses the water.

For the past several years, both interest in and action on economic incentives, and particularly effluent charges, as one element of regional water-quality management, have been increasingly evident. Associations in the Ruhr Valley of Germany have long applied a variant of them. In principle, they are not unlike sewer service charges applied locally in this country. In 1966, Czechoslovakia imposed such a system nationally among river authorities, and France did the same in 1968. Canada adopted similar legislation in 1970. The U.S. Congress requested a report on this subject which was made in 1968 by the Federal Water Quality Administration. Concurrently, the President's Council of Economic Advisers had effluent charges under study and a demonstration test was recommended. Research on their application in the Delaware River Basin was also conducted, and more recently national legislation relating to an effluent charge system was introduced in the U.S. Senate.

Vermont was the pace-setting State in this country when it passed Public Act No. 252 of 1969 (adjourned session) authorizing the levy of pollution charges intended as an economic incentive to waste dischargers not complying with State water-quality standards. Following passage, the State of Vermont's Department of Water Resources began consideration of procedures and regulations to implement the law. The Federal Water Quality Administration, seeing in the Vermont situation opportunities for the first real practical test of effluent charges in the United States, and with significant implications for national and other State policy, recommended a thorough and in-depth analysis supported by its demonstration grant program. It seeks by means of this project a thorough development of the method in Vermont as a guide for policy elsewhere and under other circumstances. It therefore felt an immediate interest to participate in Vermont's implementation efforts.

## THE ROLE OF CONSULTANTS

Arthur D. Little, Inc., was selected as the consultant organization to provide support to Vermont's Department of Water Resources in developing and implementing the system of pollution charges enacted by the State Legislature. ADL's proposed supporting services were approved by the Department of Water Resources, included in its demonstration grant application to the Federal Water Quality Administration and approved by that agency in August 1970.

In broadest terms, the objectives sought were twofold in nature:

1. To select, develop and evaluate the effectiveness of a pollution charge structure and system which will be implemented under provisions of No. 252 of the State of Vermont Acts of 1969 (Adjourned Session), such system to encompass regulatory and administrative elements to render it operational.

2. To demonstrate to the Federal Water Quality Administration, through interpretation and analysis of all work performed in meeting objective No. 1, the problems, limitations, and potentialities of the Vermont system or variations thereof, as instrumental in policy formulation and application elsewhere.

The role of the consultant was divided into three performance phases: (i) System Development – from August 20, 1970 to December 1, 1970; (ii) Interim Consultation – from December 1, 1970 to June 20, 1971; (iii) System Evaluation – for one year beginning July 1, 1971, when the system becomes operational. The first phase is completed, and our role has been to develop such procedures, rules, regulations, and analyses as necessary to implement Section 912e of No. 252 of the Acts of 1969, Adjourned Session. We are now on call to the Department for consultation services, following which we will evaluate the effectiveness of Section 912e in operation.

More specifically, consulting work in close cooperation with the Department of Water Resources during Phase I has centered on five major tasks:

1. *To develop alternative rational bases for a pollution charge structure* which will reflect the provisions of Section 912e, the relation between wastes discharged and receiving water impact, and an economic incentive to reduce the discharge of pollutants. In this process, we considered charge concepts or systems based upon (i) charges related to annualized costs of treatment required to meet approved surface water classifications, (ii) a uniform charge to all dischargers, (iii) a uniform charge weighted by stream classification factors, (iv) a charge based upon stream damages to users resulting from the discharge, (v) a charge based upon dilution factors, and (vi) combinations of the above charge bases. Features of these systems, except the stream-damage basis, appear in the French, German, and Czech systems, in sewer service charges, and in Delaware

River Basin research studies. The concept of charges based directly on stream damage-costs has not been applied.

2. *To identify for each rationale developed the relevant data* – economic, discharge and hydrologic – necessary to implement the method. In this process, we related the adequacy and validity of data available to the Department prior to November 1, 1970, to the input data required for each charge method relevant to the Vermont situation.

3. *To assess each relevant alternative* in terms of the criteria of economic efficiency, equity, relation of charges to instream economic damages, incentive effects, administrative and technical feasibility, and income potential relative to State funding requirements.

4. Following selection by the Department of a charge method, considering our work on tasks 1, 2, and 3 above, *to design an information system* capable of permit status determination, accounting and billing, compliance tests, revenue forecasting, and potential changes in permit class and compliance needs. Also, we considered responsibilities for measurement of discharge characteristics, operating requirements, and start-up procedures. An issue of central importance was the basis for permit status determination. Section 911a provides for the granting or denial of a discharge permit dependent upon whether discharges on and after July 1, 1971 will or will not degrade receiving water quality below stream standards. An unsuccessful applicant must apply for a temporary pollution permit, and if this is granted he must pay a charge for the limited time necessary to comply with standards. Discharge permit holders will not be required to pay an effluent charge.

5. Following a report to the Department on task 4 above, *to assist the Department in developing regulations, formulas, schedule of charges, procedures and supporting documents.* Here, we dealt with the three most immediately important considerations: charge structures within the selected method, permit application forms, and regulations to be published as a forerunner to public hearings.

## SUMMARY OF CONSULTING SERVICES – PHASE I

### Charge Method

An effluent charge method or system that is "pure" in the sense of directly reflecting off-site damage costs as well as on-site treatment costs in its rate structure, "complete" in the sense of encompassing in its coverage all dischargers and all types of effluents, and "permanent" in the sense of its indefinite application over time, remains a concept rather than a system actually in practice.

Moreover, it is very unlikely that a system combining these three features could be made operational in the short term with the requisite ingredients to assure equity among all affected parties and economic efficiency in its outcome.

Such a system is desirable, operating in conjunction with such other water-quality management measures as low-flow augmentation and financial assistance, to foster the economically optimal allocation and use of the increasingly scarce assimilative capacity of water-resource systems. Similarly, operating in conjunction with stream classifications and quality standards, such a system would tend to minimize total economic and social costs for given levels of desired water quality. However, two limitations presently stand in the way of its practical application: (i) the absence of quantifiable data on off-site economic damage costs incurred by all downstream or instream water users, and (ii) the lack of a means to measure and analyze accurately the complex interactions over time between discharged and natural pollutants and the hydrology of receiving waters throughout water-resource systems.

It is recognized that Section 912e of the Vermont Statute expresses that the Water Resources Board, in establishing charges,

> ". . . shall attempt to approximate in economic terms the damage done to the users of the waters, both private users and the general public, caused by the degrading effect of various types of waste in varying volumes and frequencies of discharge upon water qualities of the different classes of waters."

Also, this Section expressly incorporates the principle of an economic incentive. In these respects, it seeks application of the pure effluent charge method, data and analytical limitations notwithstanding.

However, other provisions of the Statute distinguish the method to be implemented in the State of Vermont from systems conceived or applied elsewhere. First are the provisions of Sections 911a and 912a which differentiate between dischargers who may receive permits to discharge and are not required to pay a charge, and those who may receive temporary pollution permits and are to be charged. Thus, to the extent that some effluents from some dischargers are outside the system, it is not a "complete" charge system applied to all effluents that enter receiving waters.

Further, the temporary permit shall be valid only for the period of time necessary for the permit holder to place into operation the facility, system or method contemplated in his application as determined by the Department (Section 912(d)). Thus, to the extent that corrective measures are forthcoming – and such would seem highly probable – the Vermont charge method is not indefinite over time in its application, and the emphasis is on short-term incentives.

The rational basis for choice of a charge method therefore seemed to require a response to the needs of a temporary, partial permit-plus-fee system. Moreover, since the charge to be established is "the price to be paid per unit of waste discharged," and the discharge is related to stream standards, the effect is to impose effluent standards upon dischargers. Finally, since the system is to be operational shortly, the need is for a practical charge method supported by data and analysis of data readily at hand.

In reviewing and evaluating alternative charge methods we had two objectives in mind. First, we desired to place our consideration of alternative methods in the general context of water quality management. An effluent charge system is but one of several techniques available for the management of water quality. Since some charge methods are limited in purpose and necessarily imply use in combination with noncharge techniques, we felt these relationships needed to be clearly articulated. This point must be underscored because much of the past thinking about effluent charges has proceeded on the assumption that all effluent charges serve a single purpose – water pollution control. While this is true, it is seriously misleading because water pollution control subsumes a number of different water quality management tasks, some or all of which may be accomplished by either effluent charge techniques or noncharge techniques.

Our second objective was to suggest that effluent charge method which seemed most appropriate to the pattern of water quality management (including both charge and non-charge management techniques) chosen by the Legislature of the State of Vermont and incorporated in Title 10, V.S.A. as amended. The most significant features of the Vermont pattern of water quality management are as follows:

- The determination of desirable levels of water quality by legislative and administrative deliberation through the establishment of categories of water uses, classification of streams and lakes by water use and determination of water quality characteristics required for each category of use. (§ 902-907)

- The implementation of stream standards via a universal permit system designed and administered by the Department of Water Resources which would specify for each discharger permissible and impermissible levels of waste loading such that when all dischargers complied with the terms of their respective discharge permits, the quality of receiving waters would not be degraded below established standards. (§ § 909, 910a, 911a)

- Special authorization via "temporary pollution permits" of discharges of certain wastes which *would* reduce the quality of receiving waters below established standards. Such authorization can be granted only under special circumstances and in the public interest of providing time during which the degrading effects of such discharges can be abated. (§ 912a(a)-(d))

- The fixing of "pollution charges" to be paid by holders of temporary pollution permits for their temporarily authorized discharges which, as the statute states, "represent an expropriation of a valuable public natural resource for private or limited use." Such pollution charges are to be imposed for the principal purpose "of providing the economic incentive for temporary permit holders to reduce the volume and degrading quality of their discharges during the limited period when such discharges are authorized." (§ 921a(e))

The first three features set forth above clearly envision noncharge techniques for their effectuation. The fourth expressly calls for a special purpose effluent charge system – temporary in nature, limited in scope and applicable only to dischargers who do not qualify for a discharge permit but who can qualify for a temporary pollution permit.

In suggesting a charge method suitable to Vermont and reflecting the statutory purpose, we felt the economic incentive of the charge had to operate in two dimensions. First, the time period for which a discharger was eligible to receive a temporary pollution permit should be limited as much as reasonably possible. Since this period depends in part on the time necessary "to research, plan, construct, install and operate acceptable abatement facilities," delays could be encountered in providing proper treatment for wastes. That is, as long as it is cheaper to delay, exaggerate the time needed for meeting effluent standards, and petition for renewals of temporary permits than to provide proper treatment, there would be a strong economic advantage in doing so. Thus, we felt it important to remove this economic incentive to delay and to establish equity as between those who had already qualified themselves for discharge permits and those who had not. Only an annual effluent charge equal to discharger's annualized cost of providing acceptable treatment will serve this purpose.

The second dimension of the economic incentive called for in the statutory purpose concerns temporary measures (short of constructing and operating the required facilities) which would reduce the volume and degrading quality of discharges during the limited period for which a temporary permit is valid. Such temporary measures include process and product changes, lagooning, simple housekeeping practices, and others. To encourage this type of activity, we felt the effluent charge should be some multiple of annualized cost of treatment, giving room for charge reductions which reward temporary reductions in discharge of wastes without impairing the incentive to avoid delaying the construction and operation of required treatment facilities.

Our preference for the annualized cost-of-treatment method as most appropriate was guided by one other statutory consideration in addition to the pattern of water quality management and the special pollution charge purpose discussed above. Section 912(e)(2) of 10 V.S.A. indicates the factors the Board may incorporate in fixing pollution charges. That section states:

> "(2) How established: A pollution charge is the price to be paid per unit of waste discharged into waters of the state. The charge may vary among different types or classes of wastes to account for variations in the water quality standards of different classes and the hydrologic conditions of different receiving waters. In establishing the charges the board shall attempt to approximate in economic terms the damage done to other users of the waters, both private users and the general public, caused by the degrading effect of various types of waste in varying volumes and frequencies of discharge upon water qualities of the different classes of waters. In determining relative degrading effect the board may employ any scientific or technical criteria or parameters such as biochemical oxygen demand and suspended solids and may express the unit charge in terms of such standards of measurement."

The "price per unit of waste discharged" provision of this subsection is little more than a definition of a pollution charge. Subsequent provisions of this subsection make it clear that the price per unit need not – and in all likelihood should not – be uniform. In essence, a price per unit of waste is a mathematical convention since an effluent charge, regardless of the method selected for its computation, will always yield a per unit rate when divided by the number of units of waste to which the charge is applicable.

The number of units of waste to which a charge is applicable is determined in Vermont through the administrative process of reviewing applications for discharge and temporary pollution permits. That is, the permissible and impermissible levels of waste loading designated by the Department will take into account different types and classes of wastes as well as different classes and hydrologic conditions of receiving waters.

Finally, the annualized cost-of-treatment method does approximate as closely as possible under current data constraints, the damage caused in economic terms to other users of the waters by the degrading effects of those wastes subject to an effluent charge. That this is the case can be appreciated by examining the process of stream classification and standard setting.

When stream classifications and standards are adopted by the Board and ratified by the Legislature, very significant judgments are made about the relative value and cost of different water uses. If these judgments are rational, as one must assume they are, then for each stream segment water quality standards are set where the marginal value of nonwaste disposal uses equals the marginal value of waste disposal uses. A stream's value for waste disposal is, of course, measured by the abatement and treatment costs necessitated when standards prohibit the use of the stream for waste disposal. Thus, a stream standard reflects the judgment that water of lower or higher quality will not optimize the total value of the uses of a waterway among competing users. Waste discharges which degrade receiving water quality below established standards – i.e., those discharges for which a charge must be paid in Vermont – cause damage to other users of the waters equal to or greater than the costs of their abatement to dischargers in the judgment of the Board and Legislature. In this way a pollution charge based on annualized cost of treatment will approximate the damage caused in economic terms to other users. The charge will equal or be slightly less, but never exceed, the value of such damages as implied in the stream standards.

Under these several circumstances, we suggested to the Department that a charge method based upon annualized costs of treatment of discharges seemed the most appropriate, rational and straightforward approach for initial implementation. Within this basic *method*, a variety of structures can be considered. These include a uniform charge to all dischargers subject to the charge, a uniform "zonal" charge weighted by stream classification, and a similarly weighted charge structure varying by class of discharger (municipal, industrial), by subclassifications of type and size, and by type of pollutant.

### Charge Structure

Having set these boundaries, we turned to an assessment of administrative or structural alternatives against the several criteria specifically to be considered.

adding those of constitutionality and economic efficiency to those of equity, incentive effects, relation to instream economic damages, administrative feasibility and income potential. Because the constitutionality question might well be governing or overriding, however well or poorly the other tests are met, it received first and most detailed attention. This priority has not been accorded the subject in most of the academic literature on effluent charges.

It would seem that all of the essentially administrative alternatives or variations which structure effluent charges on a cost-of-treatment method would meet the constitutionality requirements of due process and equal protection when employed for the purpose of motivating compliance with established effluent standards. Alternatives which create classes on the basis of specific economic activity or which operate on an individual case-by-case basis, would probably satisfy these requirements the most unambiguously. A uniform charge, generally or by stream zone, or charges based on general economic activity would be more crudely germane to the legislative purpose intended but, given the presumption in favor of legislative reasonableness, would also meet the usual tests of constitutionality for a valid exercise of the police power.

Turning to a second criterion, none of the alternatives or variations structured on a cost-of-treatment charge method will relate *directly* to instream economic damages (off-site damage costs) almost by definition. They may do so indirectly depending upon the degree to which stream standards – and related effluent standards in this situation – implicitly reflect within them an economic value to recreation and other amenities of the State's watercourses and waterbodies.

Incentive effects on dischargers, a third criterion, will be closely associated with the level of various charge structures, will be less predictable as one departs from specific individual or municipal size or industry class charge structures toward zoned or generally uniform applications, and will vary as the economic health (ability to pay) of the firm or industry or the municipality varies. However, the temporary nature of permits in any event may render response of dischargers in a limited period and in an *economic* sense of secondary importance.

The broadest view of economic efficiency implies the balancing of marginal on-site and off-site costs, i.e., "internalizing" the latter within a regional or river-basin area or areas, such that total costs are minimized for a given stream-quality standard or set of standards, or alternatively public and private decisions combine to produce an "optimal" quality management system including standards. The effluent charge can assist in this process, but we must look here and now to a less ambitious test of economic efficiency. This must apply to the individual, town, firm or industry – and more precisely to the temporary pollution permit holder.

As charge structures move from the general, or uniform, to the specific, the tendency will be toward inducing greater efficiency. More important, efficiency will depend upon options available to the discharger in his process of responding. A temporary pollution permit holder who faces a charge structure based upon a cost-of-treatment method need not necessarily – it would seem – install primary or secondary treatment or its industrial equivalent. He may wish to choose other ways to correct the conditions which occasioned his becoming a temporary permit holder in the first place; and this should – it would seem – be acceptable to the State, so long as other ways are at least as effective as treatment. If they are, and lower in cost as well, purposes of Section 912e are realized by the State and in an economically more efficient manner by the individual.

The remaining criteria are somewhat interdependent in that, to seek a "good" measure of one will usually involve sacrificing, trading off, or accepting a less favorable measure of another. This applies most forcefully to administrative feasibility, a criterion which is interdependent with *all* other criteria. Thus, efficiency is generally absent in a perfectly uniform charge and perhaps greatest as the charge structure is zoned, classed, sized, and individualized. But this comes at ever-increasing administrative cost, as well as sacrifice of revenue if one assumes that a uniform charge would need to be set high enough to have an incentive effect on all temporary pollution permit holders. Similarly, there is a superficial equity attaching to a uniform charge – or uniformity by zone, or for that matter, by seeking a physical goal of secondary treatment or its equivalent by all dischargers – and it is administratively quite simple. Again, however, just consideration of all parties in a truly equitable sense demands more of the administrative system and probably results in less revenue.

### Administrative Procedures

After thorough review and discussions, the Department advised us to proceed with design of an information system to support the annualized cost-of-treatment method. Also, upon a review with the Department of initial Intent to Discharge Reports – required by September 1, 1970, under Section 910a – and other available data, a rough approximation was made of the number of temporary pollution permits likely to be administered initially. It appeared that no generalized classifications within the basic method were needed, but rather that the charge structure could be individualized to each permit holder, with the possible exception of many small householders and commercial dischargers, and to the stream classifications and standards which he faces.

While the Vermont Statute's Section 912e was at the center of deliberations through October 15, it was Section 911a(c) that required major attention thereafter, as we turned to design of an information system to support the charge system. This Section sets the *general* basis for permit status determination: a discharger will be granted or denied a discharge permit, depending upon whether his effluents degrade water quality below established stream classifications. The *specific* basis for this determination is far from simple, yet it must be just and defensible.

We have found available data on hydrologic characteristics adequate, but data on discharge characteristics inadequate, for a reasonably precise, just and defensible determination. We have also found inadequate the tools or techniques for analysis of the interaction of these two sets of data as effluent discharges and streamflow (or lake water) mix.

In order to correct initially – before next July 1 – for the first inadequacy, we designed a rather detailed Application Form for all dischargers, required by Section 911a(a), which would supply to the Department much of the required discharge data. The Application Form would be submitted with one of three Schedules: A for municipalities, B for industries and public institutions, C for domestic and commercial dischargers. Some 400 applicants are expected to use Schedules A or B and an undetermined number will need to submit a brief Schedule C.

Analysis of complex and dynamic flow-effluent interaction in streams could best be achieved by a water-quality simulation model. Such an analytical tool would serve both for initial status determination and for later compliance monitoring. Since this is not available, engineering judgment must be used for the first need and a program of sample monitoring for the second.

The technical judgment of the Department may be supported by one of at least three approaches suggested by us:

1. *Direct Test against Stream Standard.* This would compare the applicant's or applicants' expected individual or cumulative loading(s) on and after July 1, 1971, together with an assumed low-flow hydrologic test condition – say the seven-day, 10 year or five-day, 20 year flow – against the stream standard. The Department would then judge the likelihood of impairment of stream quality below standard at an acceptable level of risk. Such a test would be uniformly applied.

2. *Uniform Effluent Reduction Requirement.* This would require a minimum percentage removal of polluting constituent – BOD, solids, heat, or any other – from the applicants' expected gross or raw effluent loads, selected on the basis of Departmental judgment of likely assurance that standards would be met. It could be applied uniformly for all or zoned by classification reach. The percentage normally removed by an existing process would be compared with the administratively required percentage removal, and permit eligibility so determined.

3. *Treatment Process Requirement*. This would require a certain level of treatment, for example, "secondary treatment or its industrial equivalent." Like 2 above, except that it is in effect a facilities and practices standard rather than a specified percentage removal, the standard could be selected on the basis of likelihood of assuring that stream standards would be met, and it could be applied uniformly to all or by zones.

We assessed each of these three approaches in terms of (i) legal considerations of equal treatment and relation to the basic purpose of implementing stream standards, (ii) economic efficiency of achieving standards at least Statewide cost, and (iii) risk of failure to achieve stream standards. We concluded that the most appropriate approach would be that which required specified percentage effluent reduction below total or raw waste generation (2 above), rather than the crude direct test or the arbitrary treatment standard approach. The latter could result in requiring over-treatment or other costly and less efficient adjustments, or could fail in meeting stream standards.

We visualize advantages to mechanizing many of the procedures within the information system. Initially, however, joint considerations with the Department prompted reliance upon an essentially manual approach pending experience in administering the temporary permit-charge system that would reveal opportunities for efficient automation. The Applications comprise basic documentation. Responsibilities for providing data on waste discharge and economic (cost) characteristics should rest with the applicants, subject of course to careful review, while those for data on hydrologic characteristics should rest with the Department.

The initial accounting and billing procedures can be quite simple for the temporary pollution permit holders, and calculations cannot readily be mechanized or generalized. If these procedures are required for individual householder applicants numbering in the thousands, computerized operations would seem necessary. Currently, also, the procedures to anticipate compliance tests and changes thereto, as well as in permit status, can be manualized. Revenue forecasting, budget requirements and start-up procedures have been considered with the Department.

A final, significant problem in preparing for implementation has been that of charge schedules. While it has been suggested that actual charges should be individualized to the temporary permit holder, the question of amount remains to be answered. Here, we must again point to the incentive provisions of the Statute. Normally, in other effluent charge systems examined by us, incentive features are of a long-term nature. In Vermont, incentives come into play". . . during the limited period when such discharges are authorized." Charge schedules should therefore respond to immediate, short-term incentive needs.

We have suggested to the Department a variable pollution charge, declining during the preconstruction phase of temporary permit holder response, so as to recognize positive steps taken toward compliance with stream (more precisely effluent) standards. Thus, actions taken on preliminary treatment plant or process plans, final plans, voting of bond issues, and start of construction would merit a downward adjustment to the charge. This suggests the need for setting the initial charge somewhat higher than the actual cost that results from final plans and construction. The Department has considered such a variable feature of charges as unnecessary and undesirable. For published regulations in advance of public hearings, a fixed charge schedule is proposed and at the level of expected annualized cost.

# PART ONE

# A GENERAL REVIEW AND ASSESSMENT OF EFFLUENT CHARGE METHODS

# PART ONE

## A GENERAL REVIEW AND ASSESSMENT OF EFFLUENT CHARGE METHODS

### INTRODUCTION

The search for solutions to new or apparently new problems has an uncanny tendency to disguise classic and perhaps always unresolved dilemmas behind a variety of near look-alike proposals. The design of methods for water quality management is by no means an exception. Numerous proposals have suggested that some sort of effluent charge scheme provides the best hope for effective pollution control. Attention has focused – as it does in this report – on an evaluation of alternative effluent charge methods. But before commencing that evaluation and by way of organizing it, it is useful to look briefly behind the effluent charge proposals and to ask what organizational "model" would be employed to make social (as distinguished from individual) decisions about the burdens and benefits of pollution control.

The National Research Council of the National Academy of Sciences[1] has suggested that there are two basic "models" for decision making and its organization with regard to water quality management. One model – the optimizing model – emphasizes a search for regional, least-cost solutions through systems optimizing techniques. The other – formalist model – relies more on familiar tools of legislative procedure, administrative regulation and legal concepts and is particularly sensitive to impact on income redistribution and administratively adjudicated standards. These two models are not necessarily incompatible and are frequently found working together where the optimizing model may be used to solve certain aspects of a problem while the formalist model is applied to other aspects. The National Research Council concludes, however, that neither model alone can be expected both to produce economic rationality and satisfy legal and political conceptions of justice.

These conclusions and the polar nature of the two models merit bearing in mind in the subsequent discussion. While all the alternative effluent charge methods are designed to aid water quality management, each places a different relative reliance on the two decision-making organizational models. One effluent charge alternative – the downstream damage method or so-called "pure" effluent fee system – places complete reliance on the optimizing model for all or most aspects of water quality management. By contrary example, the dilution-factor and the cost-of-treatment methods rely largely or exclusively on the formalist model and serve directly only special pollution control purposes.

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[1] Committee on Pollution Report to Federal Council for Science and Technology. *Management and Control*, Publication #1400, Washington, D.C. 1966, at p. 203.

The balance of Part I is divided into four sections: The next following discusses the four basic tasks or purposes of water quality management. It is hoped that it, in combination with this introduction, provides a kind of taxonomy of effluent charge methods. The second section analyzes the various criteria by which specific effluent charge methods are evaluated. The third section describes effluent charge methods and their variations and evaluates each in the light of the criteria discussed in the previous section. The information requirements associated with each charge method are discussed in the final section.

## EFFLUENT CHARGE RATIONALES

### Introduction – The Rationales in General

One must bear in mind that different effluent charge methods originated in different contexts of water quality management. Different purposes were to be served – albeit all related to water pollution control – in the original development of various effluent charge schemes. In other words, "water quality management" subsumes a number of objectives to be accomplished. One must consider the objectives envisioned by the proponents of each method as well as the specific applicability of the method to the situation in Vermont.

What are the alternative purposes – objectives, rationales – to be served by an effluent charge system in the management of water quality? We believe there are four. They are more or less severable, depending upon the technique(s) selected for their accomplishment, but each must be attended to. They are:

1. To determine what the desirable (or optimal) levels of water quality should be;

2. To achieve or implement the pre-established desirable levels of water quality;

3. To establish a schedule of "user" charges that will cover the costs of a predetermined set of public water quality improvement;

4. To motivate (quite apart from the system of court ordered or enforced injunctions) compliance with prescribed waste disposal behavior.

Theoretically, at least, each of the effluent charge methods to be examined is a candidate for the solution of any, or all, of the separate purposes of water quality management. A closer investigation reveals, however, that each method is more logically suited to certain water quality management purposes and less appropriate to others. Not surprisingly the methods are usually most appropriate to the management purposes that gave rise to their development in the first place.

### Determining Desirable Levels of Water Quality

Improving water quality will restrict the uses of water by the polluter in a direct way. His and society's interests in the use of the watercourse as a waste disposal medium will be affected if and when higher water quality standards are imposed. This, however, is only one way in which quality objectives will limit water use. A variety of instream measures (e.g., flow augmentation) may also be needed if we are to reach our goals. These measures may limit the use of waterways for other purposes (e.g., power production) and thus reduce benefits to non-polluters and polluters alike.

Since the impact of the quality program will be felt by all, and since it will vary according to the quality standard set, standards-setting amounts to an allocation of conflicting uses of natural waterways among competing parties.

Long before any systematic public approach was considered, the Common Law was called on to devise an allocating technique on a piecemeal basis. In Vermont, for example, the courts have prohibited very few uses of the State's watercourses as unlawful *per se*. Thus, water may be used for domestic purposes, for recreation, for power, for ponding and for waste assimilation, dilution and transportation, subject, of course, to certain restrictions. The most important of these restrictions is that the use must be "reasonable" in the light of the competing actual uses. What constitutes a "reasonable use" can change over time with changing circumstances. "Reasonable use" is a question of fact but for guidance the Vermont Supreme Court has stated:

> ". . . the reasonableness of such use must determine the right and this must depend upon the extent of detriment to the riparian proprietors below. . . . An extent or kind of deposit, which might be of no account in some streams, might seriously affect the usefulness of others. Within reasonable limits, those who have a common interest in the use of air and running water, must submit to small inconveniences to afford a disproportionate advantage to others."[1]

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[1] *Snow v. Parsons*, 28 Vt. 459 (1866).

and later:

> "Such damages as are incident to and necessarily result from a proper use of the water must be borne; but the manufacturer has no right to do an act that in its consequences is injurious to others because it is a matter of convenience or economy for him to do it."[1]

Thus it seems that the Common Law in Vermont has devised a kind of crude "balancing of conveniences" doctrine in which the damage to downstream users is compared in some vague way and on a case-by-case basis with the water's value for waste assimilative and transport uses to the upstream discharger.

It is in trying to determine a before-the-fact, systematic plan for the allocation of water uses – and thus desirable levels of water quality – that an effluent charge system becomes relevant as a possible public management technique. Here public policy might dictate that the marginal value of all uses of water (both waste assimilative and non-assimilative uses) be made equivalent so that no shift in uses would result in a net gain to social welfare. This is the context in which proposals for effluent charges based on downstream damage have arisen.[2] Without discussing the merits and disadvantages of such an effluent charge method here, two observations need to be made.

First, in order to fulfill the management purpose of determining optimal levels of water quality, an effluent charge scheme based on downstream damage must apply to all dischargers for all quantities of discharge and not just to otherwise-established permissible levels of discharge or to otherwise-determined dischargers who are degrading water quality below already established standards. Secondly, other effluent charge systems, such as those based on uniform charges or uniform charges weighted by stream classification, either ignore the relationship between competing uses or beg the question and are, therefore, inappropriate to the rationale of determining desirable levels of water quality.

This first-listed management purpose can of course be served by regulatory techniques other than an effluent charge system. A "formalist" solution is in fact effected by Federal Requirements for stream classification and adopted in Vermont by means of joint action among the Water Resources Board Hearings, local Advisory Council deliberations, and the Department's promulgation of water use classes and quality standards. The net result of these direct regulatory measures is to set aside a certain portion of the State's waterways for waste assimilative and transport use and the balance for all other uses.

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1. *Canfield* v. *Andrew*, 54 Vt. 1 (1882).
2. Kneese and Bower, *Managing Water Quality: Economics, Technology, Institutions*, 1968 (John Hopkins Press).

### Implementing Pre-established Levels of Water Quality

If the portion of the state's waterways to be used for waste assimilative and transport purposes (as distinct from, say, recreational purposes) is determined by direct regulatory measures, the problem then arises of allocating that portion among the competing applicants for such use.[1] Again, many techniques are available. Effluent standards may be determined and expressed in terms of the amount of waste loadings. Treatment standards may be established such that all dischargers must employ secondary treatment facilities. Effluent standards may also be expressed in terms of level of treatment required, so that each discharger must remove a specified equal (or unequal) portion of his respective waste load before discharging to the water body.

Various effluent charge methods are also available as techniques for the implementation of pre-established levels of water quality. Most notable are those considered in the Delaware River Studies, i.e., the single-effluent charge (SECH), uniformly applied, and the zone-effluent charge (ZECH), uniformly applied by river zones, but variable within the river system. These two charge systems can be evaluated in terms of specified criteria for this water quality management purpose, but that is not the point here. The point here is simply to note that these charge systems are appropriate to this purpose, given a predetermined standard, whereas an effluent charge system based on downstream damages or on costs of treatment is logically unsuited for this purpose.

A downstream-damage related system would allocate more (or less) water for waste disposal uses than available under the established stream standard unless that standard happened to equate the marginal values of disposal uses with nondisposal uses of water. If, for reasons of income distribution or other public policy, standards were established which categorically restricted or controlled industrial activity without regard to the relative costs involved in the damage and the costs of alternative disposal methods, then an effluent charge system based on downstream damages instituted for the purpose of implementing stream standards would almost certainly be inefficient.

### Funding Public Water Quality Improvement Measures

This is a problem which may be encountered at several levels of water quality management. Municipal sewage treatment facilities often accept a variety of industrial wastes. Regional treatment facilities, streamflow augmentation schemes and in-stream mechanical reaeration programs all involve costs that may be covered by users or beneficiaries. Frequently decisions to employ these measures are made independently of the scheme for allocating the costs. This appears to be the case with the Ruhr area *Genossenschaften*, where water quality improvement measures of optimal or sub-optimal extent are adopted and the costs are distributed among members by charges based on dilution factors or population equivalents. Other effluent charge methods are possible for this purpose, but those weighted by stream classification, for example, would appear to be irrelevant.

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[1] This allocation is accomplished by the "pure" effluent fee system through marginal trade-offs among all parties.

### Motivating Compliance with Effluent Standards or Allowable Effluent Levels

If it is determined that water quality levels should be implemented by means of allowable effluent levels[1] – hence, in effect, effluent standards to the individual permittees, as is the case in Vermont under a system of discharge permits, then the search for enforcement techniques also leads to the possible use of a schedule of effluent charges. Moreover, this is the case whether penalties are being sought for dischargers holding neither kind of permit (outright violators of the effluent standards) or whether an economic incentive is sought for holders of temporary pollution permits. Of course, the water quality management agency has access to the courts for enforcement of its orders, but such enforcement is not automatic and requires the initiative of the regulatory agency. In certain cases injunctive relief may be politically or simply practically impossible to execute. In McCormick v. Russel,[2] for example, it was stated that the State might require a municipality to supply water of a set quality or cease collecting charges therefore and could require it to be diligent in seeking a new supply of pure water. However, the State could not require the company to relocate its plant or seek a new supply, to reach which would involve an expense greater than its entire capital stock. One can easily hypothesize a similar situation where an offending municipal sewage treatment plant cannot be shut down.

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[1] One might apply the term effluent standard, rather than "allowable effluent level." Technically speaking, however, the former applies to discharges irrespective of resulting stream quality. Nonetheless, once status discrimination among permittees has been determined and physical requirements defined, one has in fact established temporary effluent standards for individual dischargers. While 10 V.S.A., Chapter 33 does not speak of "effluent standards" but rather of discharge permits, the practical effect of issuing a discharge permit will be to designate permissible and impermissible waste loadings expressed in terms of units of constituents and type of treatment required. Such designation essentially constitutes effluent standards.

[2] 172 Pa. 506.

Clearly, not all effluent charge methods may be appropriate to providing an adequate incentive for compliance. A uniform charge system may well be ineffective for some who find it cheaper to pay the charge than comply with the effluent standards simply because treatment facilities cannot be immediately obtained and installed, aside from economic factors.

Similarly, an effluent charge system based solely on downstream damages may bear little direct relation to the purpose of motivating compliance with effluent standards. If the damage caused is less than treatment costs, the discharger will find it to his advantage to pay the fee and continue discharging. Only an effluent charge system which is somehow related to cost of treatment will reliably serve the purpose of providing an economic incentive to compliance.

To summarize this section, we underscore the very simple but crucial point that the evaluation of various effluent charge methods must take into consideration the particular water quality management purpose that is intended to be served. An examination of different charge methods reveals four separate purposes of water quality management. Each system is directly appropriate to at least one of these purposes but largely irrelevant to some of the others. The four purposes in abbreviated form are (1) determining stream standards, (2) implementing stream standards, (3) allocating project costs, and (4) motivating compliance with effluent standards.

## CRITERIA FOR EVALUATING EFFLUENT CHARGE METHODS

### Efficiency

In the idealized and conceptualized formulation of economic theory, an efficient allocation of resources is that distribution and use of resources which provides the greatest output of satisfaction. No additional output can be gained through a reallocation of resources, nor can the same output be realized through a smaller input of resources by reorganization. The relationship of costs at the point of efficiency will be such that all marginal costs (both waste reduction and treatment and value-of-damage costs) are equal. If marginal costs with respect to the unit of product were unequal, the individual with a lower marginal cost could produce one more unit, the higher marginal cost producer could produce one less, production would be unchanged, but total costs would be less through the reorganization of the use of resources. In the real world, of course, things are not all this ideal, and one must recognize such things as lack of complete knowledge, lack of complete rational behavior, "chunky" and "sunk" investments and interdependencies of pollutants (upstream and downstream) in receiving waters.

In the case of water quality management, there is wide variety of means of establishing and implementing standards. Different polluters can treat their discharges to varying levels of waste removal. To implement a stream standard most efficiently means to do so at least total cost. The least-cost means is presumably the most desirable since the resources saved can be used for other projects – schools, parks, or additional water pollution control facilities. If there is an efficient distribution of treatment levels, the marginal cost of waste treatment will be equal for all dischargers.[1] Thus, those whose costs are lowest will remove the largest proportion of wastes from their discharges and those with the highest costs of treatment will do the least treatment.

The conditions of efficiency will be established by the determination of how much treatment is carried out by each discharger. Looked at from the other direction, the manner by which the usable assimilative and waste transport capacity is distributed to the individual dischargers will determine how efficiently the stream standards are achieved. Unless the condition of balanced marginal cost of treatment for each discharger is met, the allocation of resources will be inefficient. The possibility of achieving stream standards for a lower total cost will remain until marginal costs for each discharger are equal. Appendix C offers a more detailed discussion.

### Relation of Charges to Instream Economic Damages

Closely related to the general concept of economic efficiency is the fact that the presence of pollution in water causes damages on account of additional costs of treatment for withdrawal uses and from the reduction of the value of clean water uses in the stream. The value of most recreational uses is reduced by the presence of pollution, and if the pollution is sufficiently heavy, certain uses are foregone entirely.

Ideally, damages could be used to determine the proper levels of stream waste loadings. Since the clean water uses have some value associated with them and that value declines with increasing pollution levels, there is a marginal cost associated with increasing levels of pollution. There is also a cost associated with the control of pollution, the greater the waste removal, the higher the cost. Thus, there is an efficient mix of the use of water between clean water uses and waste transport uses. That optimal mix will be at the point where the marginal damage of an additional unit of pollution is equal to the marginal cost of removing the additional unit of pollution. The ability to determine the extent of waste loads desired on the basis of damage, and indirectly to determine effluent charges by this approach, rests on the ability to establish the marginal damage per unit of pollution, or alternatively, the marginal value of reduction per unit of pollution.[1]

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[1] This criterion must be modified if one wishes to take account of upstream-downstream relationships between dischargers, instream degradation processes, and differences in stream flow. To account properly for these features, one must construct a fairly good model of instream processes.

For some clean water uses, this quantification is fairly simple. Where water use requires a certain level of purity outside the stream (such as drinking water), the damage can be equated to cost of treatment of intake water necessary to achieve that purity. Investigations have shown these costs to be small, and substantially less than the cost of effluent treatment required to maintain the stream at the appropriate purity.

Other uses such as recreation, however, are very difficult to value. Some work has been done on establishing the worth of a swimmer-day, a fishing-day, etc., but there is substantial argument on what should be included and most of the literature is about how to do it, not actually calculating the value. There is no universal value since each recreation spot is intrinsically different. Although the concept of valuing these uses is theoretically pleasant, it is operationally extremely difficult. Not only does one have to calculate the value of a recreation-day, but the marginal loss of recreation-days per unit of additional pollutant as well, along with the causal relationship between the pollution out-fall and the location of the recreation area. As pollution increases, fewer people will use the stream and the value to those who continue to use it will decrease and each of these elements must be valued.

Stream quality standards are closely related to downstream damages and imply a precise relation between the uses permitted in waters of that standard and the cost of treatment necessary to meet that standard. If it is worthwhile for society to treat wastes so that specific activities can take place in the water, then it may be assumed that those activities are worth at least what it will cost to reach the quality standard. Moreover, the marginal value of an activity which could take place in *cleaner*-than-standard water will be *less* than the marginal cost of the additional treatment required to achieve the improvement in stream quality.

Thus, stream quality standards can be taken as a proxy for downstream damages. These standards in the typical case are administratively set. The alternative market mechanism for determining the level of stream quality to be maintained requires information and market institutions which do not exist.

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[1] The setting of such value might be a "market" process between dischargers and beneficiaries of clean water. For more on this point, see Appendix C.

## Equity

The criterion of equity can be easily stated in the abstract. It is to treat like persons equally and to differentiate among those persons who are relevantly different. The operative words, of course, are "like" and "relevantly different." We find the standards developed for meeting the constitutional requirements of "due process" and "equal protection" a very good approach to the problem of defining equity. Accordingly we have examined these considerations in some detail in Part Two where we assess administrative alternatives of the cost-of-treatment charge method.

There are, however, other less formal ways of looking at equity. For example, one might wish to consider the overall income distribution of society. Judgments on how equally income ought to be distributed are, of course, spread wide and subject to much disagreement. But, in any event, the general income distribution of society is not going to be effectively altered by means of water pollution control, and we consider this approach to equity a bit wide of the mark.

Another way of viewing equity in the context of water quality management is to ask whether an effluent charge system would result in any impairment of existing "rights" or "privileges" (be they *"de facto," "de jure,"* "vested," "unvested," merely "regulated" or subject to some "taking") without some form of compensation.

Common law precedent established that all water users have a right to "reasonable use" of the water and that waste transport is one of these uses. "Unreasonable use" should perhaps require a payment to compensate individuals who are damaged or have lost a use of the water. Thus, charges for pollution could be used to pay those damaged. The damages should be only those which occur over and above the damages resulting from "reasonable use." In order to provide for equity the pollution charge must be paid to the damaged parties or used to improve the quality of water to the level of reasonable use.

The setting of stream quality standards by the State may be considered a legislative establishment of limits on the reasonable use of streams for waste transport purposes. The stream quality standards also establish the reasonableness of other water uses. Thus, the fee charged to individual dischargers who are judged to degrade the stream below standards might be used to pay those who are not able to use the stream because of the added pollution.

There is another group of individuals among whom it may be desirable to assure equity. Some dischargers are already treating their wastes, and they are bearing extra costs of operation because of that additional expense. There is a period of transition during the institution of a water pollution control law where some dischargers are ordered to construct facilities. Those who are constructing facilities are still facing lower costs of operation. But if they are charged a fee during the construction period, their costs can be raised so that the advantages of not having installed pollution control facilities earlier can be removed. There is no need to transfer the fee to treaters, since the fee has raised non-treaters' costs to the after-treatment level. Here, there is no impairment of "rights" but rather an adjustment of costs to remove the reward for not having acted in a desirable fashion before the law was passed.

### Incentive Effects on Dischargers

Pollution control, with or without grants or special tax incentives, is not directly profitable to the discharger. To provide an incentive, the fee must exceed the cost to him of compliance with a standard. Thus, the incentive effect of a fee on dischargers will be dependent on the relation of the fee to his cost of treating the waste. If the fee is higher than the cost of treatment, then the discharger will benefit by building and operating the treatment facility, since he can save the difference between the fee and the cost of treatment.

The fee can also be used to determine which dischargers treat their wastes. If the State knows what the costs of treatment are for the desired levels of treatment, then the fee can be set to provide for incentives to treat to that level. The fee should be equal to the marginal cost of removing the last unit of waste required to meet the desired standard. This assumes that marginal costs are rising at the desired point. In this case no discharger is permitted to use any of the waste transport capacity of the waters free, and any existing common law "right" to that use of the water will have been affected.

The period of construction can be shortened with the use of a fee. A fee which provides an incentive to install a prescribed level of treatment will remove much of the interest in delaying actions, for the fee will make it in the interest of the discharger to clean up his discharges, since by doing so total costs can be reduced.

### Administrative and Technical Feasibility

The administrative and technical feasibility of any charge method will depend largely on the requirements of the associated information system.[1] The term "information system" as used here represents the collection, storage and analysis of all data required for the management of a real-world system, where "management" includes such tasks as decision making and administration of various plans of action.

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[1] These requirements are discussed in detail in Part Three, both in the context of how they relate to the general purposes served by information systems in general and how they relate to the various charge methods.

The actual administration of any pollution charge method should present no major problems provided that an adequate supporting information system can be established. Therefore, the feasibility criteria must be applied primarily to the design of the information system. Two general criteria are involved: (1) credibility – can a system be designed which provides information at the level of detail, precision and accuracy which is implicitly required by the effluent charge method and (2) practicality – can the system be implemented on schedule and maintained and operated within specified budgetary constraints?

It is no easy matter to assess the information systems required for each effluent charge method with respect to these criteria. The extent to which information must be credible, i.e., to reflect the real-world system, may be of only secondary interest if people are willing to accept the "rules of the game" as established by a particular method. The practicality criteria is also subject to variation since the information system can be implemented over a period of years, and the administrative costs can be reduced by assigning data collection and reporting responsibilities to the dischargers.

As a result of this variability, the administrative and technical feasibility for any of the effluent charge methods can be viewed from two extremes. One is to assume that any method can be made technically and administratively feasible through the use of simplifying assumptions, cost sharing, and gradual implementation of an associated information system over time. The other is to design a specific information system and plan of implementation for each charge method, and then to determine whether the system so defined appears feasible under specified constraints which apply to the problem at hand.

For the purpose of this study a compromise approach is best. The general information requirements of each charge method can be established for the purpose of evaluation. If these requirements appear to be the limiting constraints in the selection of a particular method, they can be reviewed in more detail to determine whether the method should be rejected or whether the requirements can be relaxed or modified.

### Income Potential

The amount of income generated by effluent fees (as distinct from administrative fees) will depend basically on the rate per unit and the number of units. The charge levied may be for the total under some systems, or only the pollution which is discharged above the quota assigned to the discharger. In Vermont's case, the effluent fee is only to be charged to temporary permit holders. Once such parties meet the standards for a discharge permit, the income from these charges will dry up.

## DESCRIPTION AND EVALUATION OF ALTERNATIVE EFFLUENT CHARGE METHODS

This section describes and evaluates six alternative effluent charge methods. It should be recalled that an effluent charge system is but one of several techniques for water quality management – others, of course include stream and effluent standards, treatment order systems, effluent permit systems, tax incentives, public grants, regional treatment and improvement facilities, etc. It is not the purpose here to compare the relative effectiveness of non-charge water quality management techniques with various effluent charge schemes;[1] rather it is intended to examine in detail the alternative effluent charge methods themselves.

Some of these alternative methods would of necessity be used in combination with various noncharge water quality incentives. Others would rely only marginally if at all on such incentives. By and large, the less a method relies on noncharge techniques the more it uses an optimizing model for decision-making regarding the burdens and benefits of pollution control. Conversely, the more a method presupposes that related water quality management tasks will be undertaken by noncharge techniques the greater the reliance on a formalist model for decision-making. The formalist model can, of course, result in decisions which reflect economic efficiency as well as other considerations.

The figure below relates the six effluent charge methods considered to the four major tasks of water quality management. A solid line indicates that a method is primarily related to the designated management task. A dotted line indicates an indirect or secondary relationship, and a blank signifies that a noncharge method would be employed for the designated task. The alternative methods might have been denominated by their most prominent place of origin, for example, the "Ruhr" method or the "Czech" system, but we have preferred to denominate them by their descriptive characteristics indicating where similar methods may have actually been put into practice.

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[1] For an excellent review along these lines see Ved Prakash and Robert H. Morgan, Jr. "Economic Incentives and Water Quality Management Programs," prepared by Water Resources Center, University of Wisconsin, for Department of Natural Resources, State of Wisconsin, Research Report #41(1969).

| | Water Quality Management Purpose | | | |
|---|---|---|---|---|
| Charge Methods | Determine Desirable Levels of Water Quality | Implementing Stream Standards | Funding Water Project Costs | Motivating Compliance With Effluent Standards |
| 1. Downstream Damage | ——— | ——— | - - - - - - - | |
| 2. Uniform Charge | | ——— | - - - - - - - | |
| 3. Uniform Charge (weighted) | | ——— | - - - - - - - | |
| 4. Based Upon Dilution Factors | | - - - - - - | ——— | |
| 5. Annualized Cost of Treatment | | | - - - - - - - | ——— |
| 6. Based Upon Stream Quality Degradation | | | - - - - - - - | ——— |

### Charge Based Upon Stream Damages

#### Characteristics

In determining the fee to be paid by each polluter, an estimate is made of the magnitude of damages in monetary terms imposed by the effluent upon all downstream parties. The computation may be based on actual downstream damages to users of polluted water or on inferred damages to the State, which may place a surrogate damage evaluation as a function of each polluter's contribution to stream quality degradation.

#### Purposes

The rationale here is that a polluter should pay a fee in proportion to the off-site damage cost directly or indirectly attributable to his waste as it proceeds downstream.

One of the purposes associated with a damage system is to approach the economic ideal of equating marginal costs and marginal benefits of using a waterway's assimilative capacity to achieve an optimal level of water use allocation. An underlying assumption herein is that the impairment of all water uses, including conservation uses, have a measurable economic valuation which may be compared with the cost of treating wastes associated with various levels of impairment.

In addition this method is intended to allocate assimilative use among dischargers as well as to allocate a stream's use as between waste assimilative uses and non-assimilative uses. That is, no additional mechanism is required to implement the levels of water quality established by the charges since this will occur automatically.

The revenues raised by this charge method need not be paid over to downstream users in order to accomplish the objectives of establishing and implementing stream standards. If the revenues derived are retained by the State, they can, of course, be used to fund public water quality improvement projects.

### Precedent

In 1957 the staff of the Ohio River Valley Water Sanitation Commission (ORSANCO) reported on a proposed fee system based on instream damages. Owing to the highly industrialized nature of the region and the common use of water for boiler feed, cooling, or processing, damages in the proposed system could conveniently be related to river salinity. The stream damage proposal was one of two considered by the ORSANCO staff. The other dealt with a uniform cutback of saline loads at a time of low flow. The report recommended the cutback method. The entire study is considered largely hypothetical. It is of interest only in that stream damages were considered an appropriate alternative basis for effluent fees.

### Considerations and Issues

Of all systems considered, this is perhaps the most difficult one to operate. Even assuming that stream damage – pollutant relationships were documented, it would still be difficult to distribute the cost of damages to the various upstream contributors. Hard as this task is, the major problem resides in deriving and defending the basis for relating damages to stream pollutants.

With certain exceptions, stream damage in *economic* terms is not a continuous function of steadily introduced pollutants. Generally, some pollutants may be held to cause no damage until a threshold concentration is exceeded, at which point a damage event is said to occur (e.g., fish acquire unacceptable toxic levels in their tissues and are no longer safe to eat). Others may be absolutely forbidden and still others (e.g., silt) may cause damage proportionate to their amount. Many important classes of damages cannot be readily related to continuous steady state behavior of polluters because of time effects in hydrology and the time required to reach the watercourse.

Some damage events related to stream contamination are continuous and may be related in a straightforward manner to steady state polluter behavior. One of these is the relation between chloride content and the consequent industrial cost of treating water for boiler feed operations. Other examples of a direct, continuous relationship between polluter behavior and damages (or cost of avoiding more serious damages) are less common. Even in this case, however, it is difficult to estimate damages. For example, Kneese and Bower report: "... industrial costs turn out to be surprisingly insensitive to intake water quality within comparatively wide ranges – especially in regard to aspects of quality that are usually influenced by prior uses and discharge of effluents. ... The situation is surprisingly similar for municipal water supplies."

### Preliminary Assessment

A charge based on stream damages could provide for a "Pareto Optimal" allocation of resources between waste disposal and all other possible uses of those resources, if the charge per unit of waste were equal to the marginal cost of damages caused by an additional unit of waste. This charge would cause the removal of all wastes which cost less to treat than the damage caused. Each discharger will treat to the point at which his marginal cost of treatment is equal to the fee. Thus, the condition of equal marginal costs holds, the level of water quality would be achieved efficiently and the residual discharge of waste would cost the dischargers an amount equal to the damages caused.

The charges based on downstream damage will provide a means to establish equity between the dischargers and the damaged. The cost of operation for the discharger will include the damages caused; complete equity could be achieved by using the fee to pay the damaged parties for their losses. The fee will also achieve partial equity between the dischargers who are treating and those who are not. Since the dischargers who do not treat face a fee which is lower than their cost of treatment (the fee is lower or they would be induced to treat), they will not face costs as high as if they were forced to treat. However, for the period of transition while future treaters are constructing facilities, there will be a shift of income to the dischargers who are already treating. Since the downstream damage fee is greater than the cost of treatment for those who will be treating, there will be a shift of income to existing treaters during the transition period.

Downstream damages will provide incentives to treat for those whose treatment costs are lower than the charge. The level of quality will be the result of the magnitude of downstream damages.

The income potential from a fee based on downstream damage could be substantial. The revenue would be continuous since a fee is being charged for the use of the water and not just during the period of transition.

Charges based on downstream damages would be very difficult to administer. The difficulties of actually measuring those damages are immense. Each reach has to be considered separately, many of the clean water uses are social goods for which a market mechanism cannot be developed to price damages. Standards may be considered a proxy for downstream damages but no monetary values are established for those damages in the process of setting standards, so there is no basis for establishing a fee.

### Uniform Charge to All Polluters

#### Characteristics

Polluters are charged a uniform rate for each of the effluent waste constituents to which a charge is applied. The agency establishes a uniform charge per unit weight of pollutant. The most common components of the total pollutant vector to which charges are applied are the pounds of BOD and tons of suspended solids. Uniform fee rates may also be applied to total dissolved solids, heat loading in Btu's, bacterial counts, or to virtually any other quantifiable component of the total effluent vector.

#### Purposes

There are two major purposes for this system of effluent charges. The overriding one is to provide a direct economic incentive to implement otherwise established stream standards. In addition, monies can be raised to fund public water quality improvement projects. Also, some motivation can be provided to comply with established effluent standards when other regulatory mechanisms are to be used in conjunction with the effluent fee. In view of the fact that marginal treatment costs normally decrease with scale (i.e., volume of effluent), a supporting rationale for the uniform system would be that it encourages most rapid compliance from those whose contributions to stream pollution is greatest.

### Precedent

A simulation study of the Delaware River included a single effluent charge based on BOD as a possible means of achieving a given level of minimum dissolved oxygen.[1] The annual cost to the system was $12.0 million compared with $20.0 million under a uniform treatment standard, suggesting that a uniform charge method is likely to prove more economic than a uniform treatment approach for the same or similar river quality objective.

Other systems in actual use are based upon a single computation related to actual quantities of pollutant discharged. These systems distribute charges to pay for treatment costs at existing public sewage treatment plants in North America (see Appendix E). The charges in these cases are properly sewage treatment fees, rather than effluent fees, and hence are not strictly comparable.

The Seine-Normandy system is a uniform charge weighted by zone, and will be discussed in the next section.

### Considerations and Issues

A single fee system seems simple and fair. Viewed as an incentive to modify the behavior of all polluters, the single fee must cover the worst case, i.e., the highest cost of treatment experienced by any polluter. A fee high enough to assure that all polluters would gain by investing in treatment as quickly as possible may prove to be a serious economic burden to many polluters and may consequently result in undesirable economic side effects (i.e., small industries that are marginally profitable may be forced out of business). A fee low enough to preclude serious economic failure for all parties may not provide an adequate incentive to some polluters. Therefore, one is likely to establish an initial fee and adjust it in the future as may appear appropriate.

It may be possible to initiate the system on a uniform charge formula basis out of a desire to take advantage of its simplicity because of the brief time available, but with a view to evolving a more refined basis in the future. Provisions may be made for fee reduction in the case of demonstrated inability to pay provided that some arrangements can be made for planning of treatment, as in the Seine-Normandy case (Appendix E). This approach, however, places an additional burden on the administrative resources of the agency since the consideration of various applications for relief may require a time commitment that may be more advantageously applied to supervising regional plan development.

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[1] A study was made of several approaches to water quality management of the Delaware River Basin, in which a uniform treatment alternative (UT) was compared with a zoned effluent charge system (ZECH), a single effluent charge system (SECH), and a least cost of treatment charge system (LC). The total cost of achieving roughly equivalent levels of river quality was determined in each case. A requirement of uniform treatment was shown to be considerably more costly than any of the other schemes – $20 million per year for UT as compared with $7 million for the least cost alternative, $8.6 and $12 million respectively for ZECH and SECH. (See E. L. Johnson, *A Study in the Economics of Water Resource Management*, WRR Vol. 3, No. 2.)

Other issues arise with respect to the manner in which each discharger's total waste load is determined. Effluents vary in their time distribution in generally daily, weekly and seasonal cycles, upon which are superimposed random and trend components. Both the Seine-Normandy and Ruhr systems have developed specific effluent sampling requirements to approach a reasonably correct estimate of the total loading.

The regulating agency may offer alternative methods for estimating the basis for the charge, that is, a quantitative estimate of the total amount of each pollutional component to which a charge will be applied. The Seine-Normandy Agency, for example, has developed a set of standardized tables which contain estimates of unit discharge of several pollutional components per level of industrial production activity, or per unit population served by an outfall. The standard table automatically becomes the basis for fee computation, unless the polluter elects at his own expense to conduct an effluent sampling program under a set of strict procedural directives spelled out by the agency and under agency supervision.

### Preliminary Assessment

A uniform charge per unit of waste will tend to induce dischargers to treat to the point where their marginal cost of waste removal is equal to or greater than the unit charge. If each discharger faces equal marginal treatment costs, one of the conditions for efficient allocation of the waste transport capacity will be met. The other condition concerns how and where the stream standards are met or exceeded. A uniform statewide fee would have to cause over-treatment in some places in order to meet the least favorable conditions.

Since the uniform fee is not specific to any one discharger, one cannot relate it to either actual treatment costs or downstream damages. The uniformity of the fee means that a fee tied to downstream damages for one part of the river or state will not necessarily meet downstream damages elsewhere. In most cases, the fee will overstate or understate those damages.

The incentive effects depend on the relation of the fee to the costs of treatment for the individual dischargers. The uniform fee may provide incentives by being greater than the cost of treatment in some areas but not in others. The levels of quality resulting from the uniform charge will vary. If the charges are set to clean up the most difficult reach, i.e., the reach with the highest treatment costs, many other reaches will exceed their standard.

The uniform fee can provide partial equity between the sufferers of downstream damages and dischargers who cause the damage. If the fee is set on the basis of a generalized damage, equity will be achieved in that reach of river where the charge is equated to downstream damage. In other reaches, the uniform fee may not meet downstream damages and thus, will continue the shift of income from the damaged to the discharger. Any fee will shift income from dischargers as compared with the situation before the imposition of the fee. If the fee is greater than downstream damages, the income redistribution will be greater than necessary. However, unless the fees collected are paid to the damaged parties, the redistribution is not really taking place. The benefits derived by dischargers from pollution will be taken away from the dischargers.

As among dischargers, a uniform fee will result in equity in the sense that they all pay the same rate per unit of discharge. The total payments to the State will, of course, vary depending on their own individual cost-of-treatment functions and the quantities of raw waste generated.

If the uniform fee is based on a generalized cost of treatment, equity can be established between those who are treating and those who are not. To the extent that the fee does not equal the cost of treatment, the shift of income will be to existing treaters if the fee is greater than the cost of treatment, and the shift will be incomplete if the fee is less.

Administrative simplicity of a uniform charge makes it appealing. Once the fee is set the only information required is the amount of waste discharged. However, if the fee is based on downstream damages, the uncertainty as to their magnitude will tend to make the system suspect and vulnerable. A fee based on cost of treatment would be more defensible as there is a good deal of data on the unit cost of removing various wastes. In order to achieve acceptable water quality, some resetting of the fee may be required as experience is gained with the responses of dischargers.

Looking ahead, the uniform fee could, in effect, be a device to "rent" waste assimilative capacity; the fee would be a source of revenue to the State. The fee would be designed to control the amount of wastes in the water. Thus, if the fee were very high, revenues might be very small since virtually every discharger would be induced to clean up his wastes; a fee designed to maximize revenues would not necessarily result in very clean water.

## Uniform Charge Weighted by Stream Classification or Zone

### Characteristics

The general characteristics of this system are identical to those for a uniform charge system, except that the charge may be varied depending upon the classification of the receiving waters.

### Purposes

All purposes discussed under the strict uniform charge apply here as well. In addition, a stream-classified uniform charge method could influence regional demographic and industrial growth in a manner consistent with water quality objectives. A differential fee could be a factor in determining the location of new housing and industry and could encourage or discourage development along streams of higher classification. A differential fee may recognize that society is willing to pay different costs to achieve differing levels of stream quality. It may also account for the different effects that similar effluents have when applied at different locations. Properly used, it could come closer to making the level of treatment fit local conditions than would a single state-wide charge.

### Precedent

The Seine-Normandy system in France is a uniform fee system weighted by zone. It was not clear from the source available (see Appendix E) what the basis was for zone differentiation. Presumably river classification was a factor, but other considerations may have entered.

The Seine-Normandy system uses a standard estimating table to compute effluent quantities, with the option available to the polluter of submitting at his expense a basis derived from actual sampling of his effluent. Provisions are made for procuring tax relief when economic hardship can be demonstrated.

This alternative corresponds to the ZECH system of the Delaware River study discussed previously. In that study it is interesting to note that the ZECH system was second best to the LC system by a relatively small margin, as compared with a uniform treatment or unweighted effluent fee applied uniformly.

### Considerations and Issues

In addition to the considerations and issues that surround any charge system, one must settle how receiving waters are to be classified, and establish the rate for each classification.

Stream classifications have been established in the State of Vermont and in principle could be a basis for fee rate differentiation. There would be some inefficiency or dislocation because the same effluent applied at two points in the river network could have very different impacts upon receiving water quality; in one case, degrading the stream to below standard conditions, in the other case, not doing so. Two conditions determine this difference, one hydraulic-hydrologic, the other "developmental." The first concerns the interaction of natural or regulated river flow, and the movement of sediments, including the dynamics of erosion and deposition. This is particularly important in lakes and reservoirs where solids high in organic constituents create bottom sludge, which poses serious nuisance problems. Even with treatment, nutrients contained in sewage can induce growth of algae in lakes, ponds and reservoirs.

One might wish to modify a simple stream classification scheme to take account of the different effects of similar effluents. The simplest approach would be to create the following classifications within each major class: lakes, streams that flow into lakes less than "x" miles from the point of effluent discharge, streams that flow into lakes more than "x" miles from the point of effluent discharge. The "x" mile specification may vary throughout the system according to the agency's best judgment regarding the degree to which lakes must be protected, taking into account a variety of physical and economic considerations as appropriate in each case.

The developmental aspect depends upon the degree of interdependence among polluters who discharge effluents in the same local water reach. A given polluter may not degrade the stream below an established standard when he is the sole discharger, but his incremental contribution to the stream, when others are already degrading it to the standard, will result in substandard quality. To the extent that development is not reflected in the selected standard, one could use the ratio of total effluent to streamflow to determine a subclassification for uniform fee by zone. Clearly there are a great number of possible subclassifications. While using a lot of them could permit a flexible and perhaps efficient system, the more there are the more difficult will be their administration.

**Preliminary Assessment**

The assessment of the uniform fee holds when that fee is weighted by stream classifications. The flexibility introduced by considering stream classification allows the fee to be directed toward meeting specific local quality standards.

However, the costs to reach a specific level of water quality in one reach may be quite different in another, so that if the fee is set to achieve B standard water in one reach, that fee may be only high enough to reach C or D water in another reach, even though B water is desired. Thus, as with the unweighted uniform fee, the fees may require some tuning from time to time to achieve the specific levels of water quality desired.

## Charge Based Upon Dilution Factors or Population Equivalents

### Characteristics

A dilution factor or population equivalent index is based upon the sum of several pollutional components. Such an index provides a common comparative basis for measuring total pollutional contribution from many different sources. A schedule of unit rates (or a constant rate) applied to the loading index (dilution factor times effluent quantity) yields the appropriate fee. A more detailed description is supplied in Appendix E.

### Purpose

Except for the fact that charges are based upon a composite factor rather than on a single item (e.g., BOD), this method resembles a uniform charge method (unweighted or weighted by stream classification). Hence the preceding discussion pertaining to those alternatives may apply here as well. Whereas the uniform charge alternative bases charges upon the measured or estimated quantities of individual pollutants, the dilution factor method bases charges upon an index derived from the concentrations of several residual pollutants.

A dilution factor or population equivalent system may achieve two major purposes. It may distribute the cost of regional sewage treatment and may also aid in implementing stream standards. For example, a dilution factor may be based on the amount of dilution water needed to reduce concentrations of contaminants to levels that preclude downstream damages, especially where aquatic life must be considered.

### Precedent

A dilution factor basis is used by the Emscher and Lippe River Associations in the Ruhr Valley of West Germany. Consideration of all elements in the dilution formula is based on standard laboratory tests upon all effluent sources in the system. A related system based upon population equivalents is used by the Ruhr Association in the same valley.

The fact that some of the Ruhr effluent fee determinations are based upon dilution factors or population equivalents is only of secondary interest. The major significance of the Ruhr experience relates to institutional arrangements and the very concept of the effluent fee principle, rather than to any particular formula or technical innovation for final computation of fees. The former would be the governing considerations in any study of the Ruhr, under any of the systems of effluent fee determination discussed herein. Within the context of this section, in which a dilution factor system is presented in the context of other fee computation methods, interest in the German precedent is limited to the technical feasibility of reducing all wastes, toxic as well as non-toxic, to a uniform index basis for fee determination.

The major rationale in the German cases is the desire to distribute the total cost of operating regional water quality projects to polluters, in proportion to their contribution to total system costs. The selection of the particular schemes or formulas may not strictly represent true cost sharing, although for practical purposes, the derived formulas and procedures were considered an adequate approximation as well as a practical incentive mechanism for polluters to reduce their loadings.

A kind of precedent or analogy is found in sewer service charges to towns and industries, applied in the United States and Canada for years. Many of these charge systems are based upon dilution formulas or population equivalents. On a small scale, these systems are analogous to the Ruhr experience in that the major rationale is to finance the cost of operating the treatment demanded. Reference is made to Appendix E for a description of North American sewer charges experience.

### Considerations and Issues

Kneese and Bower[1] point out: "From the point of view of strict economic theory there is an objection to the charge procedures described above [i.e., the Ruhr systems] – they violate the principle of marginal cost pricing. . . Methods that are less than theoretically ideal may be optimal in practice, since an important element in determining the best method for actual use is the actual cost of making marginal refinements. . . . The methods used by the Genossenschaften recognize that the effluent charge is a price which provides an incentive to economize the use of scarce resources – in this case, the waste assimilative capacity of the stream and the inputs to the collectively provided water quality management system."

Thus it would appear that the fact of pricing effluents (whether the purpose is to raise funds for treatment or other regional management action, or to provide an incentive for abatement) is the dominant issue. The use of a dilution formula or a population equivalent basis is merely a technical option to charge per unit index value of effluent as against per unit pound of BOD or other constituents. It would appear that the dilution type of index is most appropriate when the assimilative capacity is defined in terms of nonimpairment of fish life as a major water use. Dilution factors derived from fish kill laboratory tests upon all effluents, as in the Ruhr, may be used to best advantage in determining each polluter's contribution to the threshold at which the aquatic life in question would be impaired.

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[1] Kneese and Bower, *Managing Water Quality*, pp. 251-252.

### Preliminary Assessment

Charges based on dilution factors are a variant of the uniform fee, which can provide considerable flexibility.

The unit charge can be based on a number of factors: the total cost of treatment required to reach the desired level of quality; the total downstream damages caused by pollutants generated in the reach; or, as the name implies, the cost of providing the necessary dilution water to render the pollutant load tolerable.

The total number of units to which the fee is applied can be set for each specific reach. Each discharger within a reach will face the same unit charge and will thus treat to the point of equal marginal cost. Thus, one criterion for efficiency is met.

The evaluation of the uniform charge method in terms of the other criteria applies as well to the dilution factor method. However, the dilution factor system places substantially greater administrative responsibility on the state agency, since it is necessary for it to assign the dilution factors. That assignment would require considerable information, but it does take reasonable account of the actual waste carrying capacity of the receiving waters.

## Annualized Cost of Treatment

### Characteristics

For a given effluent, a given treatment results in a specific annual cost for each discharger. Therefore, given the degree of treatment desired, one may compute a fee (greater than the discharger's annual treatment cost) which will provide an incentive to meet the desired treatment objective.

The degree of treatment can be set by various means, some of which are enumerated below:

1. Require a uniform treatment or uniform levels of waste reduction such that surface water of standard quality can be obtained.

2. Require uniform treatment or uniform levels of waste reduction for all effluents within a given zone, where the specification for each zone would depend upon stream classification, degree of present and projected demographic and industrial development, and local conditions such as the ability to modify streamflows through storage regulation.

3. Require individual levels of waste reduction for each effluent consistent with an optimal allocation of the receiving water's assimilative capacity. Generally, this implies the specification of an effluent standard in terms of a minimum quality requirement.

### Purposes

The purpose here is to motivate compliance with a stipulated effluent standard or level of waste effluent treatment. Administrative alternatives within the method specify whether the cost of treatment will be computed on an individualized basis or based on groups of dischargers. A "cost of treatment" program helps the planner to see what standards cost. Even though benefits are hard to quantify, a good knowledge of real costs may aid in assessing the values associated with levels of surface water quality. In addition, of course, revenues generated can be used to fund public water improvement projects.

### Precedent

The Czechoslovak system, enacted in 1966, establishes a "basic indemnity charge" based on each discharger's annualized cost of treatment. (See Appendix E for description.) The manner in which the required level of treatment in each case is determined is not specified in the Act itself. Apparently, there is some other administrative formula used by the Czech River Board to determine required degree of treatment. The Czech law provides for an optional determination of the fee from an engineer's estimate as against a standard table. In addition to the basic charge, the system provides a surcharge tax based upon an assessment of the degree to which the net effluent discharged will degrade the river quality.

### Considerations and Issues

Having determined the degree of treatment to be required in each case, the annualized cost of treatment must be determined. The cost of treatment will be related to the nature of the treatment process required, as well as to the degree of waste reduction required. In the case of industrial effluents, treatment processes may be as variable as the production processes that generate the wastes.

From an operational standpoint, an agency would appear to have two alternative approaches to cost estimating.

1. Base costs on an engineering design of the treatment process proposed for each effluent.

2. Base costs upon standard tables relating factors such as population served, level of particular industrial product output, etc., to standardize treatment costs under specific degrees of treatment. These tables are generally derived on a statistical basis taking into account a variety of technical considerations relating waste product and waste process discrimination. The cost of treatment derived in this case is a statistical quantity with an associated probability that a randomly selected effluent will have a given cost of treatment. For example, if mean costs are used as the standard basis, an individual estimate for a typical polluter has a 50% probability of being exceeded when the plant is actually built.[1]

Since the purpose of an effluent fee considered here is to provide an economic incentive to treat or otherwise ameliorate a waste discharge condition, a first step in the direction of treatment is an engineering design of a treatment process. If the agency is not equipped to provide the necessary engineering design in each case, the fee may be used to encourage the polluter to invest, as a first step, into producing a detailed engineering report and design, which would include a properly documented estimate of the annualized cost involved.

A logical approach that suggests itself, therefore, would be to initially allow the polluter an optional basis for treatment cost computation. Should he elect to have the agency compute his fee using the standardized table approach, the agency may encourage him to proceed with engineering design by assigning a fee with a high probability of exceeding actual treatment costs.

If the regulation agency maintains the power to alter degree of treatment required as conditions in the State change, the system would appear perfectly appropriate for the longer term, with the understanding that the State will not act "unreasonably." For example, a discharger who may have been required to invest in primary treatment in 1965, or a township with a combined sewer system that met prior regulations, should not be required to abandon the facility in order to comply with changing regulations. Rather, the system should view compliance to changing standards in an incremental manner. A reasonable requirement may specify that the engineering design, for the level of treatment currently required must include provisions for future plant construction sufficiently large to accommodate future expansion as the volume treated grows, and as more stringent treatment requirements may be anticipated in the future.

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[1] For a discussion of planning for treatment under uncertain costs, see K. L. Shah and G. W. Reed, JWPCF (42) No. 5, p. 776-793, May 1970.

#### Preliminary Assessment

The charge method based on annualized cost of treatment is meant to motivate dischargers toward meeting administratively determined effluent levels or standards. The fee is designed to encourage compliance and thus, does not directly address the issue of efficiency. Efficiency may or may not have been considered in the establishment of effluent standards, but in any event these standards represent an allocation of the stream's waste assimilative and transport capacity to the individual dischargers.

Downstream damages are not directly reflected in the annualized cost of treatment charge. The setting of a stream quality standard reflects an estimate of downstream damages, but may not state them explicitly. In the ideal case, a charge set to motivate dischargers to meet effluent standards should be less than the downstream damages or it would be inappropriate to do the treatment. The inexactness of calculation makes it hard to compare downstream damages with fees based on treatment costs.

Equity can be established between the dischargers who are presently treating wastes and those who are not. A charge based on treatment costs will force nontreaters to bear the costs of treatment during the construction period. To the extent a charge is greater than the cost of treatment, there will be a shift of income (through lower relative costs) to the dischargers who are already treating.

### Charge Based upon Stream Quality Degradation

#### Characteristics

The charge method characterized here is modeled on the method used in Czechoslovakia. Classification is difficult because the Czech method combines elements from some of the charge methods discussed above and further combinations might be imagined. The special feature of the Czech system, however, is that it incorporates the relationship between a discharger's effluent and the stream flow at his location in the computation of the charge. Thus, the relative deterioration in stream quality attributable to each discharger is factored into the effluent charge.

In the Czech system, a discharger's loading of suspended solids and biochemical oxygen demand is divided by the streamflow to give the "calculated stream deterioration" caused by him. This calculated deterioration is then set over an otherwise-determined standard "unit of deterioration" to give a fraction expressed as an index. The fraction is then applied to the discharger's annualized cost of treatment to determine a surtax which he must pay in addition to his annualized cost of treatment. The two charges together constitute the discharger's effluent fee.

### Purposes

The fundamental purpose of this charge method as employed in Czechoslovakia is to motivate those dischargers who are not treating their wastes or who are doing so insufficiently to speedily complv with effluent and/or treatment standards and to employ short-run measures to abate their discharges in the interim. Revenues derived from this charge method may, of course, also be used to fund public or regional water improvement projects. It is also possible that a charge based upon degree of stream degradation could be structured to implement stream standards if an adequate water quality model were available and if the "basic unit of deterioration" were appropriately calibrated.

### Precedent

As indicated above, the Czech system instituted in 1966 provides the model for a charge based upon stream quality degradation. The Czech system is discussed in greater detail in Appendix E. It should be apparent here, however, that the "surtax rate," representing the degree of stream deterioration attributable to a discharger, need not necessarily be applied to a discharger's annualized cost of treatment. It could, for example, be applied to an otherwise uniform charge or to a charge based on population equivalents or on a dilution factor. A uniform charge weighted by stream classification or zone somewhat resembles a charge weighted by degree of stream deterioration. The latter, however, may reflect relative impact on a common resource much more precisely and individually.

It is also worth noting that a charge method which takes some account of degree of stream deterioration reflects in a crude way downstream damage caused by the discharger. We say "crude" because degree of stream deterioration does not measure damages on a monetary basis and because equal degrees of stream deterioration at two different locations will not in all likelihood represent the same amounts of damage to downstream users of the surface water.

**Considerations and Issues**

A stream quality degradation method places a larger burden upon the administrating agency than any other except a stream damage system. To determine each polluter's share in the degrading of stream quality, a water quality model is required to combine data on the location and loading of each polluter with the stream hydrology and to estimate the proportionate contributions from each polluter.

A reasonable water-quality model is not outside the state of the art, as evidenced by recent technical literature, but it would take time to develop and validate such a model. A good model will come with time but there are problems. One recent paper[1] finds that correlating model calculations with river quality measurements may pose formidable difficulty in identifying all sources of actual pollution for inclusion in the model. Recorded sources of effluent discharge were shown to account for 25%-40% (in one case as little as 7%) of the BOD loading, which, according to the model, was required to explain the observed dissolved oxygen levels in the rivers.

**Preliminary Assessment**

Since the basis for the charge under this system is the stream quality loss imposed by each effluent, it is closely related to the dilution factor method. One possible measure of the "cost" of stream quality loss is the cost of its mitigation or repair; since dilution is one way to restore quality, its cost can be a reasonable estimate for the "cost" of the loss in stream quality. The greater the degradation caused by a particular effluent, the greater the amount of dilution water required to restore the stream to the desired level of quality.

Since the stream quality degradation charge may provide for a uniform rate wherever streamflow is identical, so as to meet a specific stream quality standard, it may offer local efficiency or optimality. The administrative problem is to determine the extent of quality degradation rather than the dilution factors. The difficulties and range of possibilities in constructing waste-loading accounts for rivers and lakes has been covered above.

The preceding assessments of the dilution factor and uniform charge methods in terms of equity, incentive effect and income potential apply with substantial equivalence here. Equity can be approached as between dischargers and sufferers of downstream damage, as well as among dischargers responsible for similar degrees of stream quality degradation. As between dischargers who are already treating and those who are not, the relationship of the fee to individual costs of treatment will determine the extent of any relative shifts of income.

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[1] "BOD Mass Balance and Water Quality Standards," in Water Resources Research, Vol. 6, No. 3, June 1970.

The incentive effects will again depend on the relation of the fee to individual discharger's costs of treatment — some will treat their wastes while others will find it to their advantage to pay the fee and continue polluting. A charge based on stream quality degradation could be a constant source of revenue if applicable to all discharges and used to implement stream standards. Here again one either assumes satisfaction with the resulting water quality, which will tend to decline over time, or arranges to adjust the basis for the charge accordingly.

## DATA REQUIREMENTS FOR VARIOUS EFFLUENT CHARGE METHODS

The charge methods examined in previous sections remain to be considered generally in the light of requirements that each may impose upon an information system to support operations and administration. The basic data needs of any charge method will be extensive when one recognizes the variety of contaminating constituents of effluents, the number of discharges, their location and variable frequencies and the hydrologic conditions to be encountered. Subsequently in Part Three these several requirements are examined in more detail. Here, we offer a preliminary assessment in terms of the six methods under consideration.

### Charge Based on Downstream Damages

The charge under this method will be some function of the dollar damages imposed by an effluent on all downstream parties. It may be based on actual damages or inferred damages. If the charge is based on actual damages, operation of the information system will have to include detailed monitoring of each discharger's effluent load vector, streamflow and stream quality values, and all nondisposal uses and their associated cost/benefit functions — assuming such uses, including conservation, have measurable economic values over a requisite range of physical conditions.

These data must be stored in historic data files and at the end of regular intervals, say each month or year, they must be analyzed using a two-part calculation. The first summarizes the costs and benefits actually incurred by all downstream water users during the interval as a result of actual conditions. The second calculation must modify the actual stream quality vector by subtracting the loading due to excess or damaging pollutants contributed by each discharger, i.e., the difference between his actual load and that which he would discharge if his treatment measures were such as to preclude downstream damages. This modified streamflow must then be applied to downstream users' cost and benefit functions to derive a second set of costs and benefits. The difference between the two calculations becomes the base from which to calculate effluent charges. This approach, using *actual* damages, requires a massive collection of historic data (i.e., observed during the year) as well as some very complex methods of analysis. The information system can be operated only by employing fully automated techniques.

An alternate approach is to estimate the value of damages by a similar two-part calculation, but using average values for waste discharges, streamflow and downstream uses. This approach eliminates the substantial demand for field data, but only after sufficient initial data have been gathered to establish average values. The analytic requirements remain essentially the same.

The scope of the information system depends also on the number of quality parameters considered. The most common is BOD/DO, which requires that the analytic routines have the capability for modeling the assimilative capacity of the stream. This capability in turn requires data on reaeration and deoxygenation coefficients for each stream reach, as well as data to reflect benthic actions, natural organic loadings, and, of course, the BOD loading from all dischargers regardless of the damaging or non-damaging nature of their effluents. Non-degrading pollutants seem to involve a much less complicated analytic procedure, but this is not necessarily the case. The effect of nutrients on the eutrophication of lakes and ponds is an example.

It seems clear that a method of charges based on downstream damages is presently infeasible to implement because of the substantial demands placed on design and operation of an information system. While it is technically feasible to develop a suitable system, its functioning would require fully automated techniques supported by extensive data banks. The time needed to make such a system operational must be a major factor to consider in the selection of this charge method.

### Uniform Charge to All Polluters

Under this method, it is first necessary to establish a charge rate for each waste constituent, i.e., dollars per pound of BOD or per unit of heat expressed in Btu's or other units of measure. The total charge then becomes the sum of the products of each constituent waste load and its applicable rate. The term "uniform charge" stems from the fact that the rate schedule would be uniformly applied to all dischargers, or to all those on whom a charge is to be levied within the area of jurisdiction.

The uniform charge method places two demands on the information system, first for establishing the rate schedule, second for administering the charge system. All potential dischargers must be listed and the waste load discharged by each expressed in terms of each polluting constituent and the time variation of its discharge. The next step depends on the primary purpose of objective associated with the establishment of the charge. If the purpose is to raise revenues, the total amount of such revenues needed will have to be established, and then the rate structure can be set so as to yield the desired amount. If the purpose is to serve as an incentive for the early completion of necessary treatment, it becomes necessary to obtain the annual cost of treatment for each discharger and then set a charge rate which will equal or exceed the treatment costs for any polluter. If the purpose is to reflect the amount of downstream quality degradation or damages, it is necessary to obtain physical stream data and water use data and to develop some appropriate analytic routine for setting the rate structure.

Once the rate structure had been established, it is a simple task to calculate the individual charges and administer the operation of the plan, since the essential data will already have been collected for the purpose of establishing the rate structure. The major demand on the information system occurs therefore during the implementation phase of the uniform charge method, and this fact is often overlooked when this method is considered. The apparent simplicity of using a uniform charge method is primarily associated with the ease with which the charge structure can be explained to the public, and individual polluters can readily calculate the charges which they would expect to face.

A variation on the above approach involves the use of a flexible rate structure initially set on the basis of judgment and then readjusted periodically on the basis of the observed changes which actually occur in resulting system water quality. In essence, one increases the charges until the desired levels of stream quality are achieved. This approach is not appropriate to short-term situations in which compliance with stream standards is sought within a limited time-period. The concept often arises during the general consideration of charge methods since it relates to the behavioral response of individuals to an induced "market" condition. If the method were adopted, the demands on the information system would be felt less initially than during the operational and surveillance period.

The flexible charge rate approach may be used in conjunction with charge methods other than one based on a uniform charge to all polluters, but it is perhaps most applicable to this method because of the difficulty of selecting appropriate uniform rates to accomplish the overall management objectives.

### Uniform Charge Weighted by Stream Class or Zone

This charge method makes the same demands on the information system that the previous method does and, in addition, requires that separate charge rate schedules be established for each stream class or zone. Since streams in almost all states are in fact classified by segments or reaches – and in many, quite short reaches – this task represents an added requirement under this charge method. It is, of course, necessary to obtain data indicating the stream classification where each discharge occurs, but this presents no serious problem.

### Charge Based on Dilution Factors or Population Equivalents

The charge method here resembles the two previous methods except that it is based on a composite factor for the polluting constituents in the applications currently in practice. The information system requirements for all three methods can be compared by use of the following equations:

(a) Uniform charge:

$$\begin{gathered}\text{CHARGE(I)=SUM [RATE(P) X LOAD (P,I)]}\\ \text{P = 1,N}\end{gathered}$$

(b) Uniform charge by stream class or zone:

$$\begin{gathered}\text{CHARGE (I) = SUM [RATE (P,Z) x LOAD (P,I)]}\\ \text{P = 1,N}\end{gathered}$$

(c) Dilution factors or population equivalents:

$$\begin{gathered}\text{CHARGE (I) = RATE * FUNCTION [LOAD (P,I)]}\\ \text{P = 1,N}\end{gathered}$$

The subscripts for the variables are shown in parenthesis and are represented as follows:

I – individual dischargers
P – polluting constituents
N – the total number of constituents
Z – stream classes or zones

The function in the dilution factor method can be established in various ways, but the intent is to combine the effects of various polluting constituents in order to develop a common pollution index. The rate, although shown as a constant, can be a schedule which varies as a function of the pollutant, thus: RATE(P), or as a function of the stream class or zone, thus: RATE(Z).

The information system requires knowledge of the volume of discharge and the concentration of pollutants for each discharger in order to determine the loads. With this knowledge, an appropriate rate structure can be established as a function of the primary purpose, i.e., revenue, incentive to install treatment facilities or adjust processes or affect on-stream quality or damages. Additional information may be required depending on the purpose involved. The information requirements for the administration of the system are minimal once the rates have been established, since most of the data will already have been collected for that purpose.

### Annualized Cost of Treatment Charge

The charge under this method is based on the annual cost of maintenance and operation plus the amortized value of capital expenditures. Methods for estimating annualized treatment costs are presented in Appendix F.

The information system requirements for this method seem at first less demanding than for some of the other methods, since no downstream quality analysis or rate schedules appear to be involved. However, the treatment costs which must be determined are those for facilities which the polluter must install in order to come into compliance with some pre-established standard. In order to determine such costs, a preliminary design is required, and for this purpose information about the nature of waste discharge and receiving water characteristics and classifications are necessary. Thus, the annualized cost of treatment method does not necessarily reduce the total information requirements, although some of the responsibility may be shifted to dischargers' design engineers.

As with other methods, there is an opportunity to reduce data and analytic requirements by the use of simplifying assumptions or approaches. One approach of this kind uses standard curves showing average treatment costs for municipalities and industries as a function of plant size; this approach fails to account for costs which vary for each installation, such as municipal sewer system costs and land and damage costs.

### Charge Based on Stream Quality Degradation

Here the charge is determined as a function of the stream quality loss imposed by each effluent. The information system requirements are somewhat similar to those for the downstream-damage method except that data on downstream reach classifications and standards must be substituted for the types and amounts of water use, the associated cost/benefit functions, and the functions relating use to water.

This charge method requires considerably less data than for other methods, but the analytic requirements remain much the same. The only way the effect of an individual discharger's waste load on all downstream reaches can be determined is with the use of a detailed water-quality model. The model must first be operated with the discharger's load included, and then without it. The change in the stream quality is then determined and serves as a basis for determining the charge.

There are several variations of this method which can serve to simplify the analytic requirements. (For example, the number of pollution constituents considered in the analysis may be limited to BOD, SS, and Btu's; the degree of deterioration measured may be limited to wastes directly discharged rather than for all downstream reaches.) A further simplification assumes that water quality in streams before wastes are added is fixed, e.g., at the average values established by standards for the reach. This essentially eliminates the need for a water-quality model since each waste load is in effect added to "standard" quality water. Only stream classification and flow rate at the point of discharge must be known, and the analytic requirements consist primarily of making simple dilution computations.

Summarizing, it is evident that any of the six effluent charge methods that we have examined and assessed will impose substantial information and analytic requirements. These will vary by the complexity of physical characteristics to be encountered, each associated with demographic, economic and hydrologic uncertainty. The evaluation is further complicated because of the range of structural variations possible within each method. These can range from very accurate structures which provide a high level of technical credibility and equity, but which have high administrative costs and implementation time, to very simple structures which would yield very different results. Thus while data considerations are not overriding in a choice among most methods, their implications must be recognized in the final selection process.

## NOTE ON THE LEGISLATIVE BACKGROUND IN VERMONT

The 1969 Act, No. 252, which gave rise to this study of effluent charge systems, was by no means an initial attempt at water pollution control in the State of Vermont. In fact, it was an amendment, albeit very significant, of an existing Water Pollution Control Statute.

The first major legislative attack against water pollution on a systematic state-wide basis occurred in 1943. In that year the General Assembly enacted No. 109 of the Acts of 1943 entitled, "An Act Providing Means to Control Pollution of Streams and Water,"[1] and declared its policy to be:

> ". . . to preserve and improve the purity of the waters for the protection of public health, animal and aquatic life and for the use of industry, agriculture, and recreation."

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[1] V.S. (1947) § 6304 *et seq*.

This Act prohibited any source of pollution not existing before June 1, 1943, but expressly exempted from this prohibition (i) those engaged in the manufacture of war materials, (ii) the fertilization of fields and crops, (iii) all municipalities and individuals using the waters for sewage disposal, and (iv) mill and manufacturing enterprises operating before the passage of the Act. Clearly, the prohibitions were not intended to apply to very many dischargers. Moreover, any orders issued by the then Water Conservation Board were constrained to consider the costs involved in the light of benefits to be derived.

In 1949 the General Assembly approved and enacted the New England Interstate Water Pollution Control Compact and amended certain sections of the 1943 statute.[1] These amendments adopted the State's first classification of waters into the A, B, C, and D categories and made provision for further classification by the Water Conservation Board. In addition, requirements were established for petitions and authorizations from the Board for any increase in the sources of pollution after the date of enactment, and municipalities were required to file maps and plans of their sewage collection and disposal facilities.

The Water Pollution Control Act was again amended slightly in 1951[2] and 1953,[3] in the first year to authorize the Board to take action against parties who degraded waters below the established standards, and in the second to appropriate money to carry out the terms of the Act over a two-year period. The classification categories were redefined in 1961 and 1967.[4]

In 1964 a major amendment was enacted which gave power to the Board to enter on private lands for the purpose of water pollution inspection, to examine records and to require records to be maintained and submitted to the Board which pertain to disposal systems and related water quality projects.[5] The 1964 Act stated its purpose as follows:

> "It is the purpose of this Act to amend the Vermont statute annotated pertaining to water resources by further classifying the waters of Vermont to protect, maintain and improve the quality and quantity of the waters of Vermont for water supplies, the propagation of wildlife, fish and aquatic life, aesthetic value and for domestic, agricultural, industrial, commercial, recreational and other legitimate uses; to provide that no waste be discharged into the waters of the state

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1. Acts of 1949, No. 148.
2. Acts of 1951, No. 131.
3. Acts of 1953, No. 188.
4. Notes 10 V.S.A. Chap. 33 (1959).
5. Acts of 1964, No. 37 (Sp. Sess.), 10 V.S.A. § 579.

> without first being treated to such degree or to protect all legitimate beneficial values and uses of such waters; to provide for the prevention, abatement and control of new or existing practices harmful to water quality; and to clarify and expand the duties of the Vermont Water Resources Board so as to make these objectives more susceptible of accomplishment."

Presumably this statement of legislative intent is as valid today as when set forth in 1964.

The 1969 Amendments which became largely effective on April 4, 1970, constitute a major revision of the 1943 statute as theretofore amended. They provide for discharge reports, discharge permits, temporary pollution permits, the revocation of previously issued permits on July 1, 1971, enforcement powers and increased penalties for noncompliance. In addition, of course, the 1969 law contained § 912(e) providing for effluent charges applicable to temporary pollution permit holders.

# PART TWO

# A METHOD, STRUCTURE AND SCHEDULE FOR VERMONT

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# A METHOD, STRUCTURE AND SCHEDULE FOR VERMONT

## INTRODUCTION

### Preference for an Annualized Cost-of-Treatment Charge Method in Vermont

In the review and assessment contained in Part One of this Report, we placed our consideration of alternative charge methods in the general context of water quality management. As we indicated there, an effluent charge system is but one of several techniques available for the management of water quality. Since some charge methods are limited in purpose and necessarily imply use in combination with noncharge techniques, we attempted to articulate those various relationships. In the remaining two parts of this Report, we focus on the selection of a charge method, structure and schedule and supporting administrative procedures suitable for implementing Vermont's combined permit-fee approach to water quality management.

We suggest that a charge method based on dischargers' annualized costs of treatment is most appropriate to the pattern of water quality management (including both charge and non-charge techniques) chosen by the Legislature of the State of Vermont and incorporated in Title 10, V.S.A., as amended. The most significant features of the Vermont pattern of water quality management are:

- The determination of desirable levels of water quality by legislative and administrative deliberation through the establishment of categories of water uses, classification of streams and lakes by water use and determination of water quality characteristics required for each category of use. (§ § 902-907)
- The implementation of stream standards via a universal permit system designed and administered by the Department of Water Resources which specifies for each discharger permissible and impermissible levels of waste loading such that when all dischargers comply with the terms of their respective discharge permits, the quality of receiving waters will not be degraded below established standards. (§ 909, 910a, 911a)

- Special authorization via "temporary pollution permits" of discharges of certain wastes which may reduce the quality of receiving waters below established standards. Such authorization can be granted only under special circumstances and in the public interest of providing time during which the degrading effects of such discharges can be abated.(§ 912a(a)-(d))

- The fixing of "pollution charges" to be paid by holders of temporary pollution permits for their temporarily authorized discharges which, as the statute states, "represent an expropriation of a valuable public natural resource for private or limited use." Such pollution charges are to be imposed for the principal purpose "of providing the economic incentive for temporary permit holders to reduce the volume and degrading quality of their discharges during the limited period when such discharges are authorized." (§ 912a(e))

The first three features set forth above clearly envision noncharge techniques for their effectuation. The fourth expressly calls for a special purpose effluent charge system – temporary in nature, limited in scope and applicable only to dischargers who do not qualify for a discharge permit but who can qualify for a temporary pollution permit.

In recommending a charge method most suitable to Vermont and reflecting the statutory purpose, we feel the economic incentive of the charge must operate in two dimensions. First, the time period for which a discharger is eligible to receive a temporary pollution permit should be limited as much as reasonably possible. Since this period depends in part on the time necessary "to research, plan, construct, install and operate acceptable abatement facilities," uncooperative dischargers may have ample opportunity to be less than vigorous in providing proper treatment for their wastes. That is, as long as it is cheaper to delay, exaggerate the time needed for meeting effluent standards, and petition for renewals of temporary permits than to provide proper treatment, there will be a strong economic advantage to do so. Thus, we feel it important to remove this economic incentive to delay and to establish equity as between those who have already qualified themselves for discharge permits and those who have not. Only an annual effluent charge equal to dischargers' annualized costs of providing acceptable treatment will serve this purpose.

The second dimension of the economic incentive called for in the statutory purpose concerns temporary measures (short of constructing and operating the required facilities) which reduce the volume and degrading quality of discharges during the limited period for which a temporary permit is valid. Such temporary measures include process and product changes, lagooning, simple housekeeping practices, and others. To encourage this type of activity, we feel the effluent charge should be some multiple of annualized cost of treatment, giving room for charge reductions which reward temporary reductions in discharge of wastes without impairing the incentive to avoid delaying the construction and operation of required treatment facilities.

Our recommendation of the annualized cost-of-treatment method is guided by one other statutory consideration in addition to the pattern of water quality management and the special pollution charge purpose discussed above. Section 921(e)(2) of 10 V.S.A. indicates the factors the Board may incorporate in fixing pollution charges. That section states:

> (2) How established: A pollution charge is the price to be paid per unit of waste discharged into waters of the state. The charge may vary among different types or classes of wastes to account for variations in the degrading effects of various wastes. The charges may also vary to account for variations in the water quality standards of different classes and the hydrologic conditions of different receiving waters. In establishing the charges the board shall attempt to approximate in economic terms the damage done to other users of the waters, both private users and the general public, caused by the degrading effect of various types of waste in varying volumes and frequencies of discharge upon water qualities of the different classes of waters. In determining relative degrading effect the board may employ any scientific or technical criteria or parameters such as biochemical oxygen demand and suspended solids and may express the unit charge in terms of such standards of measurement.

The "price per unit of waste discharged" provision of this subsection is little more than a definition of a pollution charge. Subsequent provisions of this subsection make it clear that the price per unit need not – and in all likelihood should not – be uniform. In essence, a price per unit of waste is a mathematical convention since an effluent charge, regardless of the method selected for its computation, will always yield a per unit rate when divided by the number of units of waste to which the charge is applicable.

The number of units of waste to which a charge is applicable is determined in Vermont through the administrative process of reviewing applications for discharge and temporary pollution permits. That is, the permissible and impermissible levels of waste loading designated by the Department will take into account different types and classes of wastes as well as different classes and hydrologic conditions of receiving waters.

Finally, the annualized cost-of-treatment method does approximate as closely as possible under current data constraints, the damage caused in economic terms to other users of the waters by the degrading effects of those wastes subject to an effluent charge. That this is the case can be appreciated by examining the process of stream classification and standard setting.

When stream classifications and standards are adopted by the Board and ratified by the Legislature, very significant judgments are made about the relative value and cost of different water uses. If these judgments are rational as one must assume they are, then for each stream segment water quality standards are set where the marginal value of non-waste disposal uses equals the marginal value of waste disposal uses. A stream's value for waste disposal is, of course, measured by the abatement and treatment costs necessitated when standards prohibit the use of the stream for that purpose. Thus, a stream standard reflects the judgment that water of lower or higher quality will not optimize the total value of the uses of a waterway among competing users. Waste discharges which degrade receiving water quality below established standards – i.e., those discharges for which a charge must be paid in Vermont – cause damage to other users of receiving waters equal to or greater than the costs of their abatement to dischargers in the judgment of the Board and Legislature. In this way a pollution charge based on annualized cost of treatment will approximate the damage caused in economic terms to other users. The charge will equal or be slightly less than, but never exceed, the value of such damages as implied in the stream standards.

The remaining sections of Part Two discuss the considerations relevant to selection of a charge structure and schedule within the cost-of-treatment method. It should be noted here that the cost-of-treatment method was selected for implementation by the Vermont Department of Water Resources.

## SELECTION OF A CHARGE STRUCTURE

Within the charge method based on dischargers' costs of treatment, a number of what we have called "structural" variations or alternatives are open to Vermont's administering agencies in computing a schedule of charges. For example, costs of treatment may be calculated for each discharger on an individual basis, or dischargers may be grouped by size and type of economic activity and average costs of treatment determined for each group. More generalized bases for cost-of-treatment computations are also possible. All dischargers may be categorized as either municipal or industrial and average costs of treatment determined for each category. Ultimately, a single average cost of treatment may be determined for each pollutional constituent, in which case the charge becomes a uniform cost-of-treatment charge. It is also possible to vary these alternatives further by including a factor which reflects the degree of stream degradation occasioned by discharges.

## Assessment of Structural Variations

The purpose of this section is to assess structural alternatives and to provide a basis for Department selection among them. We have applied the same assessment criteria here as we used in evaluating alternative charge methods. In addition, we have assessed the structural variations against the standard constitutional tests for proper exercise of the State's police powers.

### Constitutionality

*(1) Introduction.* It is important to examine the "equal protection" and "due process" aspects of various structural alternatives within the cost-of-treatment charge method where such alternatives are employed under the State's police power for the purpose of motivating compliance with prescribed waste effluent standards. Some of the broader legal considerations regarding Vermont water law as developed by Common Law Precedent and the constitutionality of effluent charges employed for other purposes related to water pollution control are contained in Appendices A and B. The discussion here is directed to specific effluent charge structures considered suitable for the particular purpose envisioned by Section 912(e) of 10 V.S.A.

An additional introductory comment is in order. The constitutionality considerations set forth here are patterned largely on Lyman's study for the University of Wisconsin Water Resources Center;[1] however, there are some very significant differences. First, Lyman examined only effluent charge structures based on downstream damage and on cost-of-treatment and did so generally. That is, he did not investigate in any detail the dimensions along which either effluent charge might be established. Second, his analysis assumed a very general public policy purpose – "pollution abatement and control, or in other words, the reduction and control of downstream damage"[2] and did not consider the more refined and narrower water quality management purpose intended by the Vermont Statute. Third, even within the context of Lyman's analysis, his conclusion that an effluent charge system based on costs of treatment would be unconstitutional has been vigorously contested (and rightly so, we believe) by Peter Davis, General Attorney for the U.S. Department of Agriculture at the Wisconsin Water Resources Center. Thus, Davis points out in commenting on the conclusion Lyman reached:

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[1] Silus Robert Lyman, *The Constitutionality of Effluent Charges*, Technical Report OWRR A-022 Wisconsin, May 1969.

[2] *Ibid.*, p. 50.

> "The basis for that assertion is his interpretation of effluent charge systems based on treatment costs. He presumes that waste dischargers would be assessed charges on units of raw waste produced, although the amount those same dischargers introduced to the watercourse per unit volume of raw waste produced may vary greatly as a result of treatment.
>
> "Of course if that were the way an effluent charge system were set up, his conclusion would probably be correct. But all effluent charge systems based on treatment costs proposed to date are grounded upon units of waste loadings introduced into the watercourse, or upon units of raw waste produced coupled with reimbursement or credit for treatment costs. In either of those situations, there would be no unequal treatment of dischargers in equivalent situations."[1]

*(2) Constitutionally Valid Exercise of the Police Power.* The basis of a constitutional challenge to an effluent charge system starts from the common law proposition that riparians (and in some cases, especially in Vermont, non-riparians as well) have the right to a "reasonable use" of the State's surface water courses. The exact delineation of these rights is highly technical but unimportant here. The key point is that "reasonable" use comprehends not only domestic, recreational, industrial and agricultural uses but also the right to reasonable use for waste assimilative and transport capacity. Such a "right" constitutes a kind of "private property" of which a discharger might be deprived by requiring him to pay a charge before discharging waste in any amount. A discharger would then claim that the effluent charge amounted to a deprivation of private property without due process of law, without equal protection of the law, and without just compensation in violation of the 5th and 14th Amendments to the U.S. Constitution.

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[1] Peter N. Davis, "Five Legal Studies on Water Quality Management in Wisconsin," unpublished paper, 1970, p. 179.

For the purposes of this section, we assume that the issue of whether an effluent charge system relevant to the implementation of § 912(e) constitutes a "taking for a public purpose" is resolved in the State's favor, either because the "right to reasonable use" does not extend so far as to include discharges which would degrade the quality of the State's waterways below the standards established by the Board's classifications or because any interference or infringement with property "rights" constitutes in this circumstance a regulation rather than a taking. Moreover, we assume that the status discrimination between those eligible for discharge permits and those not eligible is accomplished in a constitutionally valid manner.

There remains, of course, the issue of whether a schedule of effluent charges, applicable to those not holding discharge permits or to quantities of effluent not covered by a discharge permit and imposed for the purpose of motivating compliance with established effluent standards, is a valid exercise of the police power. The valid exercise of such power must meet three tests: (i) there must be a proper legislative purpose, (ii) the regulations must bear a reasonable relation to that purpose: and (iii) the regulations must be neither arbitrary nor discriminatory. The standard for each of these tests is discussed in turn below.

(i) A "proper legislative purpose" has been defined by the U.S. Supreme Court to include protection of ". . . the safety, health, peace, good order and morale of the community"[1] and the values represented may be ". . . spiritual as well as physical, aesthetic as well as monetary. It is within the power of the legislature to determine that the community should be beautiful as well as healthy, spacious as well as clean, well-balanced as well as carefully patrolled."[2] There is little doubt that such a broadly drawn standard could be met in Vermont by a cost-of-treatment effluent charge (either adjusted or unadjusted for the impact on water quality degradation) applicable to those who would degrade water quality below the established standards. Water pollution control is unquestionably a matter of health, safety and welfare. Motivating compliance with standards that serve those purposes is merely incidental thereto.

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[1] *Crowley* v. *Christensen*, 137, U.S. 86,89 (1890).

[2] *Berman* v. *Parker*, 348 U.S. 26, 32, 33 (1954).

Section 912(e) sets forth the principal purpose as providing an economic incentive to reduce the volume and degrading quality of discharges and thereby raising the quality of waters in the State. There is no reasonable doubt, taken together with other provisions of Title 10, Chap. 33 V.S.A., that any of the cost-of-treatment based effluent structures would satisfy the "proper legislative purpose" test.

(ii) The "regulations-must-bear-a-reasonable-relation-to-that-purpose" test requires that the means selected in the light of any facts known or reasonably assumed must bear a real and substantial relation to the object sought to be attained.[1] Clearly, many particular effluent charge systems might be debatable on this point. For example, an effluent charge system based solely on downstream damage costs might not provide much incentive for abatement. However, an effluent charge based on cost of treatment is uniquely suited for this purpose. Indeed, one of the strongest rationales of a cost-of-treatment-based effluent charge is that only when a discharger is faced with a charge equal to or higher than his cost of waste treatment will he not be inclined to stall or otherwise delay taking appropriate steps to eliminate waste discharges in excess of his allotted effluent standard.

Clearly, the individualized cost-of-treatment effluent charge method is the most certain of the administrative alternatives to accomplish the intended purpose. As the cost-of-treatment computations become more generalized or standardized by groups of economic activity, the probability that some one discharger may have higher treatment costs than the average of his group increases, and the reasonableness of the relationship of the charge to the intended purpose becomes slightly attenuated. A uniform charge may in some circumstances be far short, and in others considerably in excess, of what is necessary to motivate compliance with the individual effluent standards.

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[1] *Nebbia* v. *New York*, 291 U.S. 502, 525 (1933); *Goldblatt* v. *Hempstead*, 369, U.S. 590 (1962).

The constitutionality criterion at issue here, however, does not depend on the actual success of the regulations in achieving the desired objectives but rather depends on the "reasonableness" of the regulations. Thus, any adjustment for stream quality deterioration superimposed on a cost of treatment computation (as in the Czech system) which increases the applicable schedule of fees would not materially alter this analysis. Any downward adjustments, however, could impair incentive effects.

Moreover, the presumption of legislative reasonableness lies with the State. Therefore, any party challenging the constitutionality of an effluent charge system on this point would have the burden of establishing "unreasonableness."[1] In most cases, this is a very difficult presumption to overcome, and one would think that most cost-of-treatment charge methods would be constitutionally secure in this regard.

(iii) For the "regulation-is-neither-arbitrary-nor-discriminatory" test, as nearly as we can establish "non-arbitrary" means nothing separate or distinct from reasonable and non-discriminatory. Therefore, we proceed to the non-discriminatory test. Whether an effluent charge system is discriminatory is at the very heart of the due process of law and of the equal protection of law guarantees of the 5th and 14th Amendments. Necessarily, charge methods based on cost of treatment will establish different charges for different classes of persons. The crux of the matter is that the classifications so occasioned must be reasonable in light of the purpose to be served, and all parties within a class must be treated alike. By and large, proper classification is primarily a legislative function and not a judicial one, but the courts do and will take a hard look at the classifications established. In this regard, the precise purpose to be served by the "pollution control" system becomes very important. This point will be discussed in greater detail subsequently.

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[1] *Bibb* v. *Navajo Freight Lines,* 359 U.S. 520, 529 (1959). See also *State* v. *Quattropani,* 99 Vt. 360 (1925); *State* vs. *Morse,* 84 Vt. 387 (1911); and *Purity Extract and T. Co.* v. *Lynch,* 226 U.S. 192, 33 Sup. Ct. 44.

Five judicially established standards for proper classification are widely accepted as operative.[1]

"(1) All classifications must be based upon substantial distinctions which make one class really different from another.

"(2) The classifications adopted must be germane to the purpose of the law.

"(3) The classification must not be based on existing circumstances only (i.e., it must not be so constituted as to preclude addition to the numbers included within a class).

"(4) To whatever class a law may apply, it must apply equally to each member thereof.

"(5) The characteristics of each class should be so far different from those of other classes as to reasonably suggest at least the propriety, having regard to the public good, of substantially different legislation."

A few examples may illustrate the arguments that might be advanced. Of course, waste dischargers would be subject to regulation, whereas other members of the public would not. This distinction is reasonable because dischargers are actually the real cause of pollution, whereas the general public is not. However, not even all waste dischargers are regulated. For example, farmers whose waste consists of runoff from fields and feed-lots are not regulated. Nonetheless, those dischargers who are affected by the charge represent the class wherein the need for regulation is the clearest.

More difficult is the distinction between those dischargers who receive a discharge permit and pay no charge and those who receive a temporary pollution permit and must pay a charge. Here the exact basis for granting or denying discharge permits must be an integral part of the effluent charge system. One can easily hypothesize two polluters discharging equal quantities and qualities of waste into waters classified with the same minimum quality standards, but where

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[1] *State* v. *City of Milwaukee,* 33 Wis. 2d624, 633; 148 N.W.2d21, 25, 26(1967) 11 Am. Jur., Constit. Law § 128; 37 Am. Jur., Municip. Corp. § 101; See also *Hardwick* v. *Woolcat,* 98 Vt. 343, and *State* v. *Clement National Bank,* 84 Vt. 167.

– because of accident of location, hydrology or the presence of other users of the waters – one polluter's discharge would reduce the quality of water below the established minimum whereas the other polluter's discharge would not have this effect. Whether this classification is discriminatory is difficult to assess. The precise purpose becomes crucial. In the present example, the economic incentive to reduce pollution is not the same. Moreover, similar rates are not being charged each discharger for a similar unit of waste that causes a similar amount of injury (if that be the proper test).

To take another example, actual assessments and rates of assessment might differ from waste discharger to waste discharger upon the same body of water in different locations, or upon different bodies of water or depending upon the time of year and prevailing hydrologic conditions. Such differences in charges might be justified by different amounts of downstream damage caused but not by differences of incentive effect.

If effluent charges are computed upon the basis of individual discharger's cost of waste reduction and treatment, the system would reflect such variables as the financial status of a waste discharger, the value of his land and capital improvements, the cost and technology of his production process, and the age of his production plant. It has been suggested that such a system would be dependent upon rather arbitrary considerations, would not be germane to the "reduction and control of downstream damage" and would be found to be discriminatory and therefore unconstitutional.[1] However, such a system would be most germane to providing an incentive to comply with effluent standards, where that is the purpose, in isolation from other considerations.

Each of the structural alternatives for computing charges based on cost of treatment would establish classes of dischargers in accordance with considerations germane to creating an incentive to compliance with established effluent standards.[2] These classifications would not be so constituted as to preclude additions to the numbers included within a class.[3] Even in the case of an individualized cost-of-treatment calculation where the size of the class may be very small, all dischargers with the same waste reduction and treatment opportunities would be equally treated by the effluent fee regulations. Insofar as the cost-of-treatment computations were numerically detailed and tailored to apply to more specific groups of economic activity, the classifications would appear to be based on "substantial distinctions" which genuinely differentiate between relevantly different groups of polluters.

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[1] Silas R. Lyman, "The Constitutionality of Effluent Charges," University of Wisconsin, Water Resources Center, Technical Report OWRR A-022-Wis. (May 1969 p. 49-52).

[2] See the discussion in Section (ii) above.

[3] Note that the basis for status discrimination between those eligible and those ineligible for discharge permits is not at issue here.

*(3) Summary*. It seems that all of the variations which structure effluent charges on a cost-of-treatment method, including those that adjust upward for degree of water quality degradation, would meet the constitutionality requirements of due process and equal protection when employed for the purpose of motivating compliance with established effluent standards. The alternatives which create classes on the basis of specific economic activity or individually would probably satisfy these requirements most unambiguously. A uniform cost-of-treatment charge or charges based on general economic activity would be more crudely germane to the legislative purpose intended but, given the presumption in favor of legislative reasonableness, would also meet the usual tests of constitutionality for a valid exercise of the police power.

### Equity

As the basis for the charge shifts from the specific individualized cost of treatment to a generalized average, equity becomes more a tenuous matter. Under the individualized cost-of-treatment method, equity is established between those who are treating and those who are preparing to treat, as evidenced by construction, but not operating treatment facilities. Since the costs that non-treaters face while building could be made equal to the costs they will face after completion of the facilities, equity between treaters and non-treaters could be made complete. However, as the charge basis shifts toward the generalized uniform treatment cost, the chances that equity will not be established between treaters and non-treaters increases.

Average treatment costs determined as a function of the type of activity and expressed by 2-digit SIC code would come closer to a specific discharger's actual cost than would a broad average cost table. There would still be a wide variation in treatment costs within the same industry, however, and more and more detail would be needed to work up a generally applicable cost formula. While the efficacy of the charge in establishing equity among dischargers will be raised by individualizing treatment costs, the administrative burden imposed by the establishment of accurate costs will tend to limit the degree to which perfect equity can be established.

Pollution permit holders facing different costs of treatment will pay different rates, measured in dollars per unit of discharge, if the "individualized" or "specific-activity" charge structures are chosen. If the charge schedule is based on general activity, a different charge per unit of waste will be established for municipalities than for industrial dischargers. Such differences in costs, nonetheless, will continue to confront different dischargers after acceptable treatment has been implemented and charges are no longer levied. A very superficial equity could, of course, be achieved by a uniform charge rate, but it is not usually considered inequitable when firms face different costs for factors such as labor, financing and energy, because of differences of location, credit standing, technical process, labor supply, and other "facts of life." Similarly, differences in the cost or surrogate costs of proper waste disposal would not appear to create any undue inequity among dischargers.

Insofar as sufferers of downstream damage will not receive the charges paid because of effluent which degrades receiving waters below standard, there will be an uncompensated shift of wealth away from these downstream users. Such users do, however, retain their common law remedies under § 919 of 10 V.S.A. if the requisite elements of a private nuisance action can be established. If the effluent charges are used for water quality improvement projects, this shift of wealth will be partially mitigated.

It is difficult to assess with any precision the equity implications of adjusting the effluent charge structure to reflect the extent of stream deterioration caused. Any adjustment which reduced the charges below the costs of treatment would seriously impair the incentive effects of such charges. Therefore, it is reasonable to assume that such adjustment, if made at all, would be to increase the charges. In this connection, it should be remembered that the establishment of a water quality standard implies that the extent of downstream damage exceeds the value of assimilative use when waters are degraded below the standard. Thus, some upward adjustment would tend to create greater equity as between pollution permit holders and sufferers of downstream damage.[1]

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[1] A similar purpose might be served by allowing downstream parties to make pre-emptive purchase of a temporary pollution permit. That is, if the effluent charges associated with a given temporary pollution permit were fixed at $10,000 and a group of downstream parties felt they would suffer damages in excess of $10,000 as a result of the discharge allowed under the temporary permit, they might offer to pay the state slightly more than $10,000 to obtain the permit themselves and thereby foreclose the discharger from degrading the water below the standard for even a temporary period of time. See Appendix C for a discussion of this point.

It is in trying to assess the considerations of equity as among nontreating dischargers that the real difficulties arise. For example, it is not immediately obvious whether a discharger who degrades class D waters is causing greater or less damage than one who degrades class A waters. Even if damages can be measured by an agreed-upon dollar figure, consider two pollution permit dischargers, "A" and "B" in the same reach of a river. A has cost-of-treatment X and causes damages D; B has cost of treatment Y and causes damages 2D. If each is granted a temporary pollution permit for the purpose of allowing sufficient time to implement treatment, and A is charged X and B is charged Y (without adjustment) so that each will be sufficiently motivated to begin construction of the necessary waste reduction and treatment facilities, it can be argued that charging B more than Y for his effluent is unnecessarily penalizing, given the purposes of temporary pollution permits. An opposite view can also be taken. The point here is that it is virtually impossible to assess the equity of such a situation short of additional judgmental values regarding the notion of equity.

### Economic Efficiency

As developed in previous sections more thoroughly, the broad viewpoint of economic efficiency in the "pure" or "ideal" effluent charge system, as part of more comprehensive water-quality management programs, holds that on-site or off-site costs will be balanced at the margin of trade-off, i.e., by "internalizing" the latter within a regional or river-basin area or areas. Such areas might ultimately be designated within any jurisdictional boundaries. The effluent charge is a method designed to achieve a least-cost or optimal-benefit solution.

Since off-site (instream) costs cannot presently be quantified, we must look to a narrower efficiency viewpoint and criterion. For immediate purposes of an initial charge structure, it takes the form of efficiency in the context of the individual discharger, whether the firm, the industry or the municipality. This will depend upon charge structure classifications within the cost-of-treatment method and upon status discrimination.

Given the need for status discrimination in the permit-plus-charge system and its partial participation by dischargers, no measure of relative efficiency is apparent among the optional charge structures within the basic method of alternative treatment costs. Since the temporary pollution permit holder will be responding to what in effect is an effluent standard, his response will be more or less internally efficient depending upon measures open to him to adjust to this standard. Responses may well include product or process changes, as well as treatment.

### Incentives

The efficacy of the charge in providing incentives to speed up the construction of treatment facilities does depend on whether the cost-of-treatment calculation is based on individualized costs or generalized costs. With individualized costs, the incentive can be tailored to each individual discharger, while the more generalized the basis becomes, the more likely it is that an individual discharger's cost of actual treatment may be different from the charge.

Where dischargers' costs of actual treatment are higher than the charge, the only incentive to treatment will be the threat of loss of a temporary pollution permit. The charge may be considered an extra burden, but in this circumstance, will not provide *by itself* an incentive to construct and operate the requisite waste reduction and treatment facilities.

### Administration

In terms of administration, the more general the charge, the easier the system will be to administer. If the State has to assess only a single general charge per unit of pollution to be removed, that is much less difficult to do than to calculate the cost for each individual discharger. It is possible to shift some of the burden of estimating costs onto the dischargers since, as they will eventually have to accept a price on the construction contract for the plant, they are in a position to know the costs they face. However, dischargers will be at different stages of planning and construction and their estimates of costs will be of variable reliability.

It is possible to merge these approaches to a cost-of-treatment charge structure. If a discharger has no notion of what his cost will be, the State can set a cost on the basis of a suitable generalized measure of activity. The cost should be set somewhat higher than the expected treatment cost. The State can then recalculate the charge on the basis of approved treatment facilities for which precise plans are available. Costs can be recalculated again when the contract is let. This recalculation of the charge at various stages in the process of planning and construction will provide an incentive to proceed rapidly with the installation and operation of proper treatment facilities. It will also provide an expanding information base regarding actual costs of treatment.

Any charge schedule which adjusts for some measure of downstream damage costs complicates immensely the administrative and technical task. The difficulties of calculating such measurements are discussed in Part I and that discussion is applicable here.

### Income Potential

Income potential is likely to be highest for the most generalized cost-of-treatment basis, since charges in that case must be set high enough to provide an incentive for *all* dischargers, i.e., they are determined by the worst case. As such, charges will clearly be higher for most dischargers than their individual alternative costs. In any case, income will be derived from charges for only a limited period as existing non-treating dischargers construct treatment plants, or otherwise adjust to charges. Presumably, new potential dischargers will build treatment facilities as part of their total operations and will be able to qualify for a discharge permit at the time operations are started. In any event, the income potential of an effluent charge under the present design of the Vermont Statute will be small in the long run as dischargers comply with stream and effluent standards.

We attempted to approximate potential revenues in advance of any status discrimination by means of a cursory examination of initial discharge reports. These were so lacking in data as to provide no clues as to future temporary pollution permit holders. No useful figures could be derived, and cannot be until the status of permittees is resolved.

### Relation to Downstream Damages

Cost of treatment is not directly related to downstream damage, except insofar as stream standards reflect an implicit judgment of the relative marginal values of disposal and non-disposal uses of waterways. Damages could be introduced to the charge structure by multiplying the cost-of-treatment charge by some factor to reflect downstream damage. This factor may be useful, since there is some uncertainty in the estimates of individual costs and increasing uncertainty as the cost calculations become more generalized. The damage factor would intensify the incentive to get required treatment plants built. This intensification can be accomplished by increasing the charge based on the types of downstream activities which take place or could take place. Thus, in a reach of water where there is a great deal of recreational development or potential, the charge might be multiplied by a factor which accounts for differences in stream use. This factor is similar to considering downstream damages but without the necessity to value them precisely. The factor can be applied to any of the structural alternatives of the annualized cost of treatment method.

### Technical Feasibility

In order to assess the technical feasibility of administering any of the various charge structures under the cost of treatment method, it is necessary to define each structure in detail, determine its data, information and analytic requirements, and then compare these requirements with the means available to the Department for meeting them within specified time, budgetary and manpower constraints.

If the charge structure is based on the generalized approach, it is necessary to establish a set of charge tables or curves, one for each classification to be employed. These classifications may reflect the type of waste-generating activity, e.g., municipality, industry by type, individual residence, and others. One must determine average annual costs as a function of the size of activity. This type of information is available to some extent – for treatment plant costs of municipalities (excluding sewer system costs which vary considerably), for certain types of industries, and for individual residences. There are, however, several types of industries for which no treatment cost functions are available, either because such data have not been compiled or because treatment costs are not directly related to a production index.

A charge structure based on each discharger's individual cost of treatment tends to avoid the technical problems associated with the development of a variety of generalized cost curves. Not all applicants for a temporary pollution permit will be able to obtain detailed plans for treatment facilities with the few months available, of course, and for these individuals it will be necessary either to develop cost curves from experience elsewhere or to estimate the cost of treatment using engineering judgment.

The critical factor will be the number of applicants of various types for whom treatment costs must be estimated. If there are only a few such applicants, as for example in a specialized industry, it may be easier to consider them on an individual basis. Alternately, if there are a large number, it may be preferable to develop a general cost-of-treatment function from available records elsewhere. (See Appendix F for a more detailed consideration of this question.)

### Departmental Selection

The several charge methods and their structural variations were presented in our first Interim Report of October 15, 1970, to the Department of Water Resources. The pros and cons of each were carefully considered in consultation with the ADL project staff team subsequent to October 15, and the Department advised us to proceed to the consideration of a supporting information system that would implement the annualized cost-of-treatment method. It also adopted an approach to charge structure development that is quite highly individualized to each discharger's cost situation, rather than generalized by size or type of activity. The following statement summarizes the Department's preference for a charge structure. It formed the working basis for the more detailed examination of charge schedules and supporting administrative procedures presented in subsequent sections of this Report.

> "Within the basic charge method of annualized treatment costs, charge rates and schedules shall be related as nearly as possible to individualized cost data, net of grant support and tax adjustments, as determined appropriate by the Department for the size and type of discharge under consideration and the status of plans if any to reduce discharges. Individual charges are subject to modification upon a valid appeal supported by engineering data acceptable to the Department."

## APPROACHES TO A CHARGE SCHEDULE

### General Incentive Effects

Section 912a(e) states that

> ". . . the imposition of pollution charges shall have the principal purpose of providing the economic incentive for temporary pollution permit holders to reduce the volume and degrading quality of their discharges *during the limited period when such discharges are authorized.*" (Italics added.)

To achieve this immediate, short-term incentive, the charge schedule would seem to require including some provision for reduction of the *charge* levied against a discharger in response to his reduction in effluent *discharge*, whenever such effluent reduction occurs during the temporary permit period. The pollution charge system can also incorporate other possible incentives, such as the long-term incentive for rapid completion of permanent pollution abatement facilities or procedures, and the short-term incentive to take the next step toward a permanent solution. In setting up the rate schedule for the pollution charge system, some potential conflicts between short-term and long-term incentives become apparent. These conflicts and trade-offs inherent in resolving them are discussed in subsequent parts of this section.

Before discussing incentives in detail, the potential disincentives of the pollution charge system should be considered. Levying a charge against a municipality or an industrial firm may cause some adverse reaction. First, care must be taken in explaining the system and in setting rate schedules to avoid damaging the good relations which exist between the State agencies on the one hand and individual municipalities and industrial firms on the other.

In addition, imposition of the charge may work a real financial hardship on the discharger, to the point where an industrial firm may choose to close its doors or restrict its operations. Such actions may, of course, be economically damaging to the State. In this regard, it must be noted, however, that imposition of a pollution charge based on cost of treatment cannot be blamed for such occurrences. The charge amounts basically to an early application or incurrence of the actual cost of treatment which is deemed necessary by the State to achieve and maintain desirable water quality. It is, therefore, not the charge itself, but the State's overall program for clean water, which imposes the additional economic burden on the State's industries and municipalities. If the charge system were abandoned and the overall pollution abatement objectives maintained, the problem would only be delayed.

We have assumed that the State has carefully evaluated the impact of its water quality program on the economy of the State. We are also confident that the State officials responsible for implementation of the program are well aware of the necessity to explain and interpret the several aspects of its programs to all those who will be variously affected by them.

### Short-Term and Long-Term Incentives

In balancing long- and short-term incentives within the pollution charge schedule, industries and municipalities must be considered separately. Municipalities have a stable waste load which allows few opportunities for immediate abatement by temporary or housekeeping measures; some industries, however, have considerable flexibility in the short term and can reduce their pollutional loading quickly by changes in improved housekeeping procedures, processing methods, or product mix. Furthermore, construction of waste treatment facilities by a municipality requires several interactions with the State, availability of State funds, and voting of the program funding requirements by local citizens. In contrast, industries have fewer apparent impediments to implementation of permanent abatement procedures; relatively few men are involved in the decision to proceed, little interaction with the State is required, and the availability of capital funds depends primarily if not solely on internal conditions. Bases for adjusting effluent charges and charge schedules are discussed in the following paragraphs, along with the overall incentive effects occasioned by such adjustments.

#### Municipalities

It may be desirable to adjust the pollution charge levied against municipalities during the preparatory period when waste treatment facilities are being considered and planned, in order to reflect and encourage any progress made by the municipality toward meeting the requirements of the temporary pollution permit. For example, the charge could be progressively reduced as the following steps toward compliance are taken.

- Approval of preliminary treatment plant plans
- Approval of final plans
- Voting of bond issue
- Securing ownership of site
- Beginning of construction.

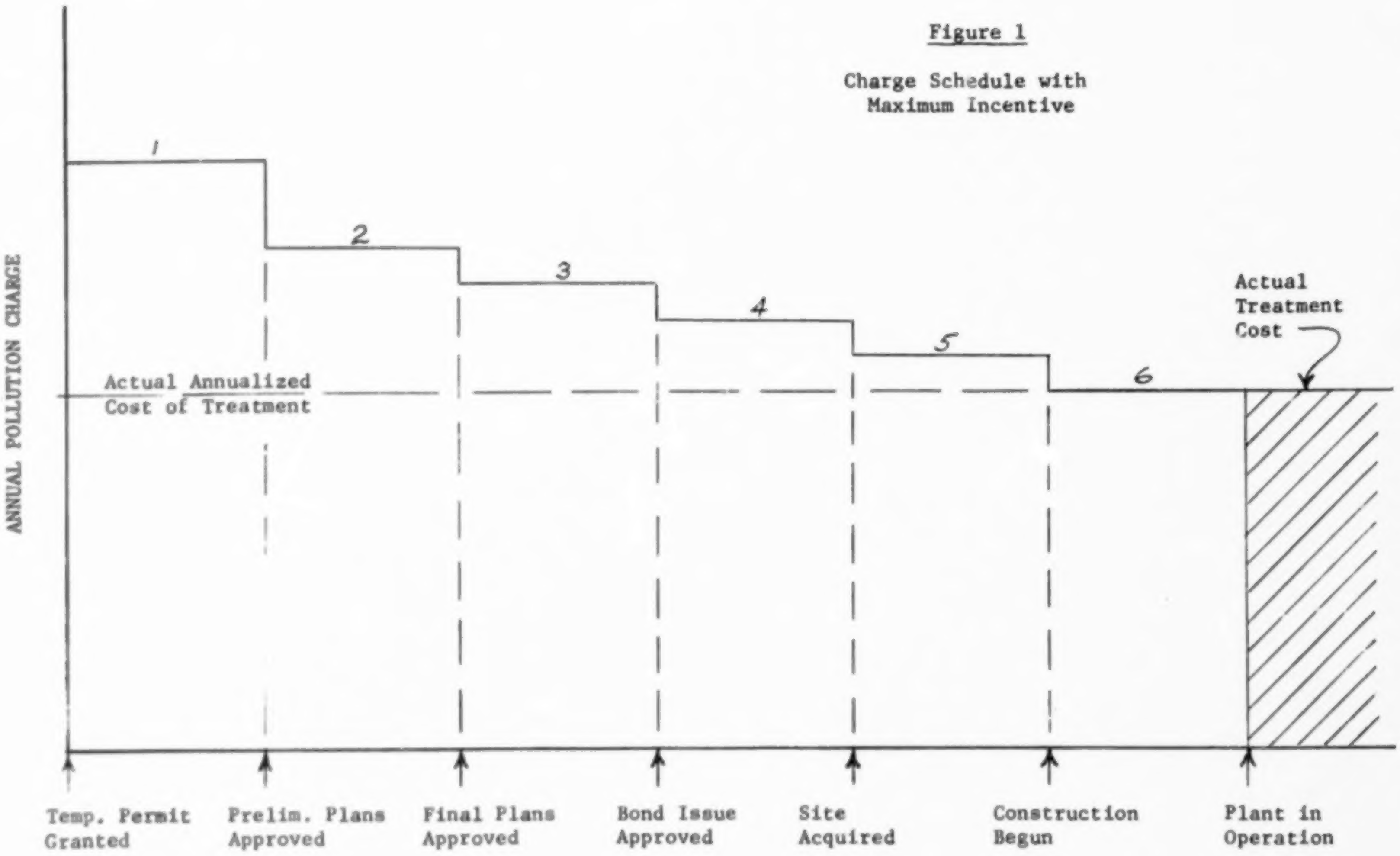
How might a variable schedule affect the overall incentive character of the pollution charge? There are two aspects of incentive that must be balanced. First, in any given year, the pollution charge plus any out-of-pocket costs to the municipality must be as high or higher than the estimated annualized cost of treatment in order to provide genuine *economic* incentive for the municipality to proceed. If the charge plus these costs is less than the annualized cost of treatment, even by a little, the economically efficient discharger will choose the lesser cost and delay his abatement program. In this case, the economic incentive effect of the pollution charge is lost, and any charge levied against the discharger is, in reality, a fine. While these statements are indisputable on theoretical grounds, in practice any charge will add some psychological incentive to those arising from public pressure to abate as well as the severe penalties in the law for not meeting the requirements of the temporary pollution permit in any event.

Second, reduction of the pollution charge as each step of the abatement program is completed does offer the municipality an immediate incentive to go the next step. The degree of incentive to take the next step is related to the degree of charge schedule reduction to be realized. A reduction of less than 10 percent for each step would perhaps not be considered significant by the temporary permit holder.

Can both of these aspects of economic incentive be maintained in the pollution charge schedule? We believe that they can be, but only if the initial charge is set high enough. Figure 1 shows, for illustrative purposes only, how the charge might be structured to maintain both incentive aspects. It is assumed that the municipality has no engineering plans at the time the temporary pollution permit is granted, and that the pollution charge in the first period is set by the Department. When preliminary plans are approved, the first specific estimate of treatment cost becomes available and the pollution charge is based on that estimate. In order to provide incentive for the preparation of preliminary engineering plans, the charge in period 1 must be higher than that which will result from the cost estimate in the preliminary plans. Just how much above the Department's best cost estimate the first-period charge should be set depends on the incentives which are to be operative during subsequent periods.

**Figure 1**

Charge Schedule with Maximum Incentive



The charge in period 2, based on the preliminary engineering plans, would be set in this illustrative instance 40% above the estimated final cost in our example, in order to allow for later charge reductions without dropping the pollution charge below the final annualized cost of treatment. As successive steps in the abatement program is taken, the charge is reduced by 10% at each step. It is assumed for the moment that State aid is available when required, an assumption which is recognized is dependent upon many external factors. The successive steps toward compliance shown in Figure 1 need not take place in the order shown, nor for that matter need there be as many step reductions as are shown in the example. For example, the site may be owned by the municipality from the outset, and credit for completing this step should be given immediately.

When the plant goes into operation, the charge is equal to the annualized cost of treatment. Discontinuation of the charge at this time just balances the addition of the actual cost of treatment, causing no net change in the financial demand on the municipality. Moreover, program-related, out-of-pocket costs associated with site acquisition and construction could be credited against the charge in periods 5 and 6 to keep the total annual program cost at the level shown.

This schedule maintains both incentive aspects: reduction of the charge as each step is taken, and less total cost to the municipality when facilities are completed and in operation. The major drawback to this schedule is that the initial charge must be set purposely high (in our example at least 40% above the preliminary plan estimate if a 10% step reduction is to be offered) in order to keep the charge from falling below the cost of treatment as the program proceeds. Will this high initial charge be acceptable to the municipalities and to the Department? This question can only be resolved by administration determination.

In the above example, it was assumed that the cost estimates contained in the preliminary and final plans are equal to each other and to the cost based on the final construction contract. The likelihood of inflation must be recognized. If the estimated cost increases by more than 10% from step to step, the increase in the estimate offsets the reduction allowed by completing the steps, and that portion of the incentive will not be realized.[1] This condition can be guarded against by increasing the percentage charge reduction at each step, but this would result in an even higher initial charge.

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[1] The increase may be due either to inaccuracies in the preliminary estimate or to inflation. Abatement costs are subject to strong inflationary pressures and adjustment of charges to compensate for inflation over the temporary permit period is a subject with which we could best deal in Phase II of this demonstration project.

The initial charge can be reduced by lowering the entire charge schedule shown in Figure 1. However, if this is done, the pollution charge in period 5 or 6 will fall below the final annualized cost of treatment and the economic incentive to proceed will be lost. One might then query whether the momentum of the program can be counted on to carry through this period. Alternatively, the initial charge can be lowered by reducing the step increment below 10%. But then the percentage reduction may be too low to serve as a significant incentive.

Another possible condition calling for charge adjustment occurs when the State is unable to make timely financial aid available to keep the program moving. Where the municipality has proceeded as far as it can and is kept from further progress by lack of State aid, the levying of an incentive pollution charge seems punitive and inappropriate to the interest and intent of the legislation. In such cases, it would seem appropriate to suspend the charge until such time as State aid is made available. State-wide pre-financing in advance of Federal grant assistance may avoid this eventuality.

### Industry

The initial pollution charge levied against an industrial firm can be based upon the estimated cost of the treatment facilities or other procedures required to reduce the discharge to an acceptable level. The estimated cost will come from engineering plans submitted by the firm, or in the absence of such plans, from a Department estimate. The same kinds of charge reductions applicable to municipalities, discussed above, could be applied to industrial programs as well. The incentive effect of such reductions may be less in the case of industry, and the administration more difficult, since there are fewer discrete and clearly sequential steps in consummation of an industrial program. For example, it is not unusual in industry for construction to begin before final plans are completed. In addition, the decisions to be made and steps to be taken are internal to the firm and proceed directly once the single management decision to proceed is made. Documentation of stepwise accomplishment may prove artificial and the small anticipated reductions in the charge, while welcome, will probably prove to be no real incentive.

The more relevant short-term incentive is that which rewards immediate reduction in pollution loading through temporary measures. This type of incentive is particularly applicable to industrial dischargers who have some immediate control over their discharges through changes in processing, housekeeping procedures and product mix. To provide this incentive, the charge schedule must allow for reduction in the charge for demonstrated reduction in discharge during the period in which the temporary pollution permit is valid.

The variability of industrial practice, together with the flexibility of an industrial firm in reducing the discharge by several means, complicates the problem of setting the initial charge and adjusting it to reflect reduced discharges during the temporary permit period. The following schedule of events shows a possible situation which might arise and possible procedures for dealing with them.

1. Discharger is denied a discharge permit and files for a temporary permit specifying his discharge and proposed treatment facilities or procedures.

2. In evaluating the application, the Department decides what portion of the discharge relates to a temporary pollution permit and what portion, if any, is sufficiently degrading and due to bad practice to require correction prior to July 1, 1971.

3. The Department grants a temporary pollution permit for a portion of the discharge related thereto, approves the proposed treatment facilities or procedures, and sets the charge based on the associated annualized cost of treatment.

4. During the first year of the temporary permit period, the discharger asserts to the Department that he will make certain *immediate* changes to reduce the discharge. These might include:

    (a) Building and operating a holding tank to smooth out the discharge over a 24-hour period and reduce the maximum discharge.

    (b) Recycling of a process stream which has the net effect of reducing the BOD discharge by 10%.

    (c) Eliminating a product from the product line, with a net reduction in BOD discharge by 10%.

5. The Department must first establish whether the change is temporary or permanent.

    (a) If the change is permanent, acceptable to the Department and *not* part of the program specified in the permit, the Department should alter the terms of the permit (specification of action and charge) to reflect the changes in the permanent abatement program required to produce the allowable effluent. If the change is permanent, acceptable to the Department and part of the program specified in the permit, credit should be given against the charge reflecting the recomputed annual cost of operation associated with the change.

(b) If the change is temporary (i.e., an interim measure which will be discontinued when the originally planned program is completed), the Department could reduce the charge to reflect the reduced discharge. How to reduce the charge while maintaining the overall incentive requires some discussion.

The fact that a firm proposes a temporary change to reduce the discharge, rather than making the change permanent, indicates that the proposed change is uneconomical in the long term. Such a temporary change will not be undertaken unless the immediate saving on the pollution charge balances the cost of the change. In general, the Department will not be able to estimate the cost to the firm (which may involve broader aspects of company economics), so that any charge reduction must be made on some other basis. The firm will then decide whether to proceed.

The simplest basis for charge reduction is pollution loading. Suppose that the present discharge is 1100 lb BOD per day and the allowable discharge is 100 lb BOD per day. The firm proposes a temporary change which will reduce the present loading to 1000 lb per day. The reduction in loading is 10% of the difference between the present and allowable loadings and the charge could be reduced by 10%. If the cost of the change to the firm is less than 10%, the firm will implement the temporary change.

Depending on the nature of the incentive factor built into the initial charge, the result of this charge reduction could be to remove the economic incentive to proceed further. The adjusted charge plus internal cost of the temporary change may be less than the cost of treatment under the originally planned program and without the temporary change, and also less than the total cost if the temporary change were made permanent and a new abatement program designed and implemented. Thus, the short-term incentive to abate pollution by temporary means may destroy the incentive to abate pollution in the long term. This potential problem is similar to that discussed in connection with municipalities. The solution is the same. By building a high incentive into the initial charge (for example, by making it 40% above estimated annual cost of treatment), the Department maintains a flexibility to reward and encourage short-term progress without destroying the economic incentive to put the long-term abatement program into operation.

The basic questions to be answered by the Department are also the same:

1. Is the long-term incentive nature of the pollution charge sufficiently important that the sum of charge plus out-of-pocket costs must always be greater than or equal to the annualized cost of long-term treatment?

2. If so, does the Department choose to defend a high initial charge in order to hold out incentives for short-term improvement?

### Departmental Selection

At this writing, the suggested approaches to charge schedules that would attempt to reflect both short-term and long-term economic incentives remain to be acted upon by the Department. A tentative draft of regulations for publication in advance of public hearings was developed cooperatively between ADL Project Staff and Departmental staff. That part of the regulations dealing with a charge schedule did not reflect the approach we had developed which would provide a short-term incentive. That is, the Departmental preference is for the annualized cost-of-treatment charge without a multiplier that would enable temporary pollution permit holders to receive a reduction in charge as a result of concrete steps taken to come into compliance.

# PART THREE

# ADMINISTRATIVE PROCEDURES

# PART THREE

## ADMINISTRATIVE PROCEDURES

This part of our Final Phase I Report is intended to provide further assistance to the Vermont Department of Water Resources in implementing a state-wide pollution charge system. We record and interpret here our consulting service activities, largely since October 15, 1970, in preparing to make operational a pollution charge method, structure, and schedule that are to date only a legislative mandate.

Earlier parts of this Report examined a number of basic rationales for effluent charges in water-quality management programs and their associated charge methods and structures. An annualized cost-of-treatment charge method emerged from this examination as the most appropriate for initial application, in the light of present circumstances and consistent with Section 912e, No. 252 of the 1969 Vermont Acts. Within this basic method, a range of choice as to classification – by location, type and size of discharger and by kind of effluent – of dischargers subject to pollution charges was presented for the Department's further consideration.

In consultation with the ADL project staff team subsequent to October 15, the Department selected the annualized cost-of-treatment charge method for development and initial implementation. Further, and consistent with our own preferences and inclinations, the Department adopted an approach to charge structure development that is largely individualized to each discharger's cost situation, rather than generalized by size or type of activity.

A pollution charge system requires informational and procedural support for its effective administration. Incorporating as the Vermont statute does both a permit and a charge system, the first applicable to all dischargers and the second only to some, particular executive importance surrounds the operational characteristics and procedures of permit eligibility or "status" determination. Under what conditions and circumstances is either a *discharge permit* or a *temporary pollution permit* to be granted or denied? All dischargers of wastes into the State's waters as of July 1, 1971, must apply for a permit. It is of central importance to the success of the law that a reasonable, equitable and effective determination be made. Much of Part Three concerns the basis of discharge permit determination.

Specifically, we have addressed ourselves to the design of an information system with the following characteristics:

1. Capability for permit status determination.
2. Accounting and billing to dischargers operating under pollution permits.
3. Compliance tests of discharges relative to approved stream standards.
4. Short-term (5 to 7 year) revenue forecasting.
5. Procedures to anticipate changes in permit class.
6. Procedures to anticipate changes in compliance tests.

Additionally, we have (i) analyzed discharge measurement responsibilities, (ii) manpower, staffing and budget requirements, and (iii) start-up procedures for initiating the system.

First of all, the *substance* of permit status determination, as distinct from the *mechanics*, seems of sufficient importance under the circumstances presently faced to warrant special discussion. This we have done in an initial "Approaches" section. Until these determinations are actually made, the precise administrative procedures that will emerge as parts of the supporting system for operations will remain somewhat conjectural.

The remaining sections are organized in large measure around the essentially mechanical design of an initial information system to support the dual permit-charge system. Clearly, the supporting information system will be refined and extended as experience is gained in operation. Early in our work, we had approached the design of the information system with a view to computerizing as much of the process as possible. Subsequent discussions revealed the Department's view that manual procedures would suffice. We have therefore pursued the manual concept of design, but have pointed out opportunities for simple automation where appropriate. The *Application for Permit* required of all dischargers is itself an essential element of the information system. We have responded to the Department's request for assistance in designing this form with considerable care.

## APPROACHES TO PERMIT STATUS DETERMINATION

### General

We have said that the Vermont approach is a combined permit-charge system. The key provision of the Vermont Statute on which earlier sections of this Report centers is Section 912e, dealing with a form of effluent fee designated as a "pollution charge." The key provision on which this section centers is Section 911a(c), dealing with the denial or issuance of discharge permits. It reads as follows:

> "If the department finds that the proposed discharge will reduce the quality of the receiving waters below the classification established for them, it will deny the application and refuse to issue a permit. If the department finds that the proposed discharge will not reduce the quality of the receiving waters below the classification established for them, it shall issue a discharge permit."

It is a matter of primary concern that the act of permit status determination – eligibility or ineligibility – be just and defensible. At the same time, we believe that a reasonably precise determination of whether discharges will reduce water-quality below established classifications cannot be made in many instances on a before-the-fact, measured-violation basis without the use of a somewhat refined computer model of the instream water-quality dynamics of receiving waters at and downstream of points of discharge. The question is: In the absence of, or pending the development of, such a test instrument, what is the best alternative procedure?

One approach that has often been discussed is that of basing the eligibility decision on whether "secondary municipal treatment or its industrial equivalent" is to be operable by July 1, 1971. Our first Interim Report set forth several shortcomings to this approach, despite its appeal from the viewpoint of simplicity. Discussions with Allen Kneese and Blair Bower[1] strongly reinforce the view that this so-called "treatment standard" approach has serious imperfections. They cite as a major weakness the high variability in design and operating efficiencies and practices with "secondary" facilities, which renders the amounts of residual effluent loadings in streams very uncertain and often meaningless.

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[1] A research seminar discussion among Resources for the Future, Inc., and Arthur D. Little, Inc., staff in Washington, D.C. on October 28, 1970.

What then are the remaining choices – between a seemingly unacceptable treatment or facilities standard and a clearly unattainable (in the short run) model-based test instrument? Clearly, Vermont has established a system of stream standards. In addition, the State Legislature has provided for the creation of effluent standards as the means to implement stream standards. It would seem necessary, therefore, in those doubtful cases of status determination, to set an allowable effluent loading that (a) relates reasonably to the stream standard and (b) is supported by an "operating practices" standard. This approach is developed in the following subsections.

### The Statutory Context

The Vermont Water Pollution Control law, chiefly 10 V.S.A., Chap. 33, provides for a universal permit system as the means to implement the various levels of water quality designated by the adopted stream standards (watercourse classifications and corresponding water-quality characteristics). Under the Vermont statute, the responsibility resides with the Department of Water Resources to establish the basis for permit status determination. Such a basis must be at once reasonable, equitable and effective. The first two of these criteria are constitutional; the third is statutory, articulated by the above-quoted §911a(c).

Neither Title 10 nor the "Water Use Classes, Standards of Quality, and Technical Guidelines" adopted pursuant thereto specifies what constitutes a finding that a proposed discharge will reduce the quality of receiving water below its classification. Since the stream standards are set in different terms with regard to different pollution constituents, they suggest a variety of bases on which such findings might be made. For example, permissible levels of dissolved oxygen and coliform bacteria are stated in technically measurable terms. Thus, permissible discharges related to these constituents may be based on direct measurement of in-stream impact or on predicted assimilative capacity, given standard assumptions about stream hydrology. Of course, in both cases it becomes necessary to take into account not only what is occurring at an individual outfall but also the point-source waste loading from other discharges into the same watercourse, and perhaps non-point source or "background" loadings as well.

With regard to other pollution constituents, such as color and turbidity, stream standards are specified in terms of what may result from "appropriately treated effluents" or "none in such concentrations that would impair any usages specifically assigned to the Class." These standards suggest (but do not require) that the process of finding that a proposed discharge will not reduce the quality of receiving water below its classification might be based on either a treatment standard or an effluent reduction requirement. The point to be underscored here is that the statute has left the translation from stream standards into permissible effluent loadings to the discretion of the Department. The purpose of this section is to discuss the substantive considerations relevant to the selection of a method for permit status determination. Such a method must effectively achieve the desirable levels of water quality prescribed by the stream standards, and it must also satisfy requirements of reasonableness and equity.

## Alternative Approaches

Given the need to review discharge permit applications before July 1, 1971, and the information requirements pertaining to the review process, we believe three alternative approaches to permit status determination merit analysis.

### Direct Testing Against Stream Standards

Under this approach the expected net discharge of each applicant, after whatever treatment or other abatement process may be employed, is examined. The expected discharge is first examined for any constituents which, by virtue of the stream standard, must be absolutely excluded from any effluent entering the stream reach in question. It is then determined whether any allowable contaminants are present in such quantity as to degrade the stream below the specified standards. This determination requires both streamflow and discharge characteristics in sufficient detail by time and space dimensions to produce a valid and conclusive test.[1]

In the absence of a water-quality model which can account for point-source and cumulative effects of several neighboring discharges, a hydrologic standard might be employed and made sufficiently severe to provide a reasonable, if approximate, individual test. In general, a greater concentration of dischargers on a given reach would require a correspondingly more severe low-flow hydrologic test condition in order to assure that the cumulative load would not degrade the stream below standard quality at some less severe low-flow condition. For example, the classification standard may require that the stream not be degraded below a specified level more than seven consecutive days in ten years, considering the cumulative impact of all dischargers. Where dischargers are concentrated on a reach, however, an individual stream impact test might apply a five-day, twenty-year low-flow test. In the absence of a rigorous stream-quality model, the appropriate individual test condition will be largely dependent upon the technical judgment of the Department.

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[1] It might be argued that *any* contaminant degrades the quality below standard at the *immediate* point of entry into the stream, hence is grounds for permit denial, but the constitutional criterion of reasonableness comes into play under this strict interpretation of quality degradation.

The major advantage of the direct-test-against-stream-standard approach which applies a hydrologic standard test condition is that it provides a clearly demonstrable, uniformly applied measurement for status determination. It does, however, lack technical precision for the long-term and is only considered as a useful alternative approach to meeting immediate requirements.

**Uniform Effluent Reduction Requirement**

As in the previous approach, the net (after treatment or other process) effluent must first be examined for constituents that are mandatorily subjected to 100% reduction. Again, it must be determined whether any of the allowable pollutants are present in such quantities as to degrade the stream below standards. Under an effluent reduction approach, this latter determination may have an indirect basis. For example, the Department may establish a minimum percentage of BOD, suspended solids or other constituent solids that must be removed from any *gross* or *raw* effluent generated, which percentage according to the Department's judgment is likely to assure that the classified standard will be met. The percentage removal required may be uniform throughout the State or tailored to reflect differences in stream classification, geographic location and density of industrial and urban development. In all individual cases, the percentage normally removed by any existing process (as of July 1, 1971) would be compared with the required percentage removal for each constituent. This would serve to establish a clear quantitative test for status discrimination purposes. As in the previous approach, and again in the absence of a rigorous stream-quality model, the determination of the appropriate percentage cutback to meet the standard will have to be made approximately and will be largely dependent upon the technical judgment of the Department.

An important consideration under this alternative is the precise definition of the *gross* effluent – not the *net* effluent – to which the cutback test is applied. This consideration applies to all dischargers, but there is a special problem with some. For example, major reductions in waste loadings from certain industrial processes may be accomplished quite simply, efficiently and at low cost (tree bark "tailings" have been cited as an example), and may in fact result in the salvaging of valuable materials as well. In such cases the Department might require that all "reasonable" non-treatment abatement opportunities be realized as a matter of expected practice prior to any treatment, and that the percentage reduction be applied to discharges after such practices have been carried out. To make and document such "reasonable" determinations requires detailed technical familiarity with the on-site performance of each industrial discharger whose present processes or practices fail to employ these initial abatement measures. In view of the Department's expressed familiarity with the relatively few such dischargers and their operations, this aspect of the uniform effluent reduction approach would not appear unmanageable.

### Treatment Process Requirement

For all waters of the State or for individual reaches of surface water, the Department may find that uniform application of a particular treatment process is desirable as a means of achieving designated stream standards. For example, the provision of secondary treatment or its industrial equivalent may become the qualifying factor for a discharge permit. Such an "appropriate" treatment process should include both proper design and satisfactory operating practices. In the absence of a water-quality model and as in the other approaches, the presumption is that the judgment of the Department as to the nature of treatment required would be reasonable.

An element of flexibility might be introduced with this approach which is best illustrated by an example. If a discharger were subject to a secondary treatment process requirement, implying a predicted gross-loading cutback of about 85%, but the actual plant efficiency or operating practices achieved only 80% removal, the Department might consider a variety of factors prior to denying a discharge permit. These may include an on-site inspection of the plant to determine that it is properly operated, inspection of design documents to ascertain that it was properly designed, consideration of the age of the plant, and projection of future raw effluent quantity that must be processed. Having determined that the discharger has indeed shown good faith, and has made very reasonable technical effort to provide adequate treatment, the Department may find it inequitable to deny a permit for the sole reason that a predicted efficiency relating to a required treatment standard was not quite met. Even in the case of new plants, the operating efficiency may differ from design efficiency. The Department may feel it appropriate to specify the nature of treatment for a reach, considering variations in efficiency, and then merely require that the design and operation of the facility be of demonstrably technical competence.

Of the approaches sketched here, there may be some tendency to assume that the second and third are very similar in that a given treatment process may be expected to result in a predictable percent of effluent reduction. Such an assumption is not valid, first because similar treatment facilities will not in fact always be operated with similar efficiency. Second, even if operating practice requirements are made part of a treatment process standard, similar facilities operated by standard practice will not necessarily give similar results under different conditions of climate, raw waste characteristics, equipment age, and other factors. Third, a discharge permit stated in terms of percentage reduction imposes a very different set of responsibilities on dischargers than does a permit subject to facilities and practices standards. Finally, even assuming that a given treatment process would always result in a given percentage reduction of gross loading, comparable reductions may be accomplished by means other than some standard treatment process.

## Assessment of the Approaches

We must emphasize again that in the absence of a water-quality model, none of the approaches provides a completely rigorous basis for determining whether the "proposed discharge will reduce the quality of the receiving waters below the classification established for them." If such a test instrument were available, a test of status discrimination would most likely be related to the "direct testing against stream standard" approach, possibly in combination with a "uniform reduction requirement" that could vary depending upon the activity class to which a discharge is assigned.

Each approach must rely upon the professional judgment of the Department and each does provide a basis for initial status discrimination. Furthermore, while the Department's judgment under each alternative may err, it is possible to assure that the error will be conservative on the side of higher water quality than is actually required. It is now appropriate to assess the three approaches in terms of reasonableness, equity, efficiency, and risk of failing to achieve water-quality standards.

### Legal Considerations

There are two major legal considerations which affect the choice of procedure for status discrimination: (i) the basis on which any particular discharge permit is granted or denied must be reasonably related to the purpose of implementing the stream standards in the reach to which the application pertains: (ii) a comparison of the bases on which discharge permits are granted or denied must display equal treatment under substantially similar conditions as among the applicants. These considerations are discussed in turn below.

### Relation of Discrimination Basis to Implementing Stream Standards

The approach which provides for *direct testing* against the stream standard offers the best opportunity for satisfying the "reasonably-related" requirement. A water-quality model which accounts for the point-source and cumulative effects of neighboring dischargers and for the biodegradation process in a waterway will allow the Department to demonstrate the impact of any proposed discharge on the receiving waters. Permits can be granted in accordance with this impact and the purpose of the discrimination satisfactorily accomplished. Such a model will incorporate the legislatively ratified, acceptable level of risk implicit in the hydrologic standard – e.g., low seven-day average flow with a frequency of once in ten years. Without such a model, it is necessary to adjust administratively the assumed low-flow condition to assure that the cumulative load in heavily concentrated reaches does not impair the stream below standard quality at the acceptable level of risk, and some estimating technique will be needed to relate the severe low-flow test condition to the extent and concentration of discharges in the reach.

A *uniform effluent reduction* approach provides a somewhat more attenuated relationship to the implementation of stream standards in the applicant's reach. If the percentage removal required is set so that the heaviest residual volume loading permitted does not degrade the stream below standard and other dischargers are required to achieve the same percentage removal, the basis for discrimination will be generally related to implementing stream standards on a state-wide basis but not very specifically related to stream standards in the reaches where some dischargers are located. As suggested earlier, the percentage removal required may be tailored to reflect differences in stream classification, geographic location, and density of industrial and urban development. As these distinctions are made with greater refinement, the uniform character of this approach begins to fade. At some point the removal requirements may become individualized. When a water-quality model becomes available, account can also be taken of differences in costs of treatment so as to promote system-wide economic efficiency. In any event, this approach will probably satisfy the legal requirement of reasonableness where the presumption runs in the State's favor.

Where the approach is based upon the provision of a *uniform treatment process*, the relationship of this requirement to the implementation of stream standards is more difficult to demonstrate.[1] Unless the treatment process required is exceedingly flexible and variable – in which case the requirement is not uniform – there will be many circumstances in which the required process will simply not result in the water quality called for by the stream standards. In some cases, a discharger may be obliged to construct and operate treatment facilities which are not really needed to achieve or maintain the stream standards at his outfall or in his reach of a river. Such "over-treatment" may occur if a given discharger can abate waste discharges by means of process or product changes more effectively than by treatment. "Over-treatment" may also occur if the total loading on one river is very different from that on another. In either case, it may be difficult to establish the reasonableness of the required treatment process in terms of achieving specified stream standards.

In other cases, a uniform-treatment process requirement may fail to obtain stream water of standard quality. This event is most likely to occur with industrial dischargers because secondary treatment, even with proper operating practices, may have absolutely no effect on certain kinds of residuals such as heat, dissolved solids or turbidity. Moreover, while it is easy to speak of "secondary treatment or its industrial equivalent," it is more difficult to determine what that means. First, there may be a number of different "industrial equivalents" appropriate in different circumstances but no one "uniform" with another. Secondly, "equivalent" presumes assessment against a common denominator or measure. If this measure is percent reduction of some gross loading, it would seem more appropriate to state this explicitly as the basis for status discrimination and allow dischargers to achieve it by whatever means they can devise, subject to Department approval.

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[1] Of course, insofar as stream standards are established in terms of what results from "appropriate treatment," there is no problem here; but such circularity may not go far to guarantee State waters of specific, measurable quality.

Whenever a treatment-process requirement results in stream quality considerably at variance from the standard, it will be difficult to demonstrate its reasonableness in the light of the standards. Attempts to adjust the required process to accommodate the circumstances of individual dischargers may undermine the only apparent advantage of this approach – i.e., the superficial equity implicit in a uniform requirement.

### Equal Treatment Among Applicants

Whatever the approach, one may expect those who feel injured by it to compare the volume loadings allowed recipients of discharge permits with the volume loadings disallowed themselves and other unsuccessful applicants. Let us assume that such a comparison shows six dischargers identified as 1, 2, 3, . . . 6 on a stretch of the same river which has the same classification along its entire length. Discharger "1" is located furthermost upstream, discharger "6" furthermost downstream, and dischargers "2" to "5" sequentially between "1" and "6." Each has indicated his proposed loading in his application, the percentage reduction proposed, and the type of treatment he will employ. These factors are summarized below:

| Discharger | Type | Treatment Process | Total % Reduction | Residual Loading |
|---|---|---|---|---|
| 1 | Municipal | A | 20 | 100 |
| 2 | Industrial | A | 50 | 100 |
| 3 | Municipal | B | 50 | 50 |
| 4 | Industrial | A | 80 | 50 |
| 5 | Industrial | B | 80 | 20 |
| 6 | Municipal | C | 80 | 90 |

The treatment designations "A" and "B" and "C" represent increasingly sophisticated processes of treatment. Thus, type "C" might represent secondary treatment where 80% removal can be expected under proper operating practices. Type "A" might represent a very simple treatment which normally will achieve 20% removal alone but which can result in higher levels of reduction when employed in combination with production process and product changes.

If status discrimination is based on "direct testing against stream standards," the results may be arranged as follows where the single digit identifies the discharger, an "S" means a successful applicant, a "U" means an unsuccessful applicant, and the number after the hyphen indicates proposed volume of residual load.

| | Type of Treatment | | |
|---|---|---|---|
| **% Reduction** | **A** | **B** | **C** |
| 20 | 1<br>S-100 | X | X |
| 50 | 2<br>U-100 | 3<br>U-50 | X |
| 80 | 4<br>U-50 | 5<br>S-20 | 6<br>U-90 |

Discharger "1" is successful because he discharges into clean water; discharger "5" is successful because of his small residual load. In this case, discharger "4" will complain that he would burden the receiving waters less than discharger "1" and has through process or product changes reduced his waste to a greater extent than "1" but has not received a permit simply because the procedure is biased in favor of upstream dischargers where effluent concentrations are lower relative to stream characteristics. Discharger "6" would make a similar complaint and add that he has installed the most sophisticated and expensive treatment facilities as well.

If permits are granted on the basis of a required uniform treatment process, the results may be displayed thus:

| | Type of Treatment | | |
|---|---|---|---|
| **% Reduction** | **A** | **B** | **C** |
| 20 | 1<br>U-100 | X | X |
| 50 | 2<br>U-100 | 3<br>U-50 | X |
| 80 | 4<br>U-50 | 5<br>U-20 | 6<br>S-90 |

Here discharger "5" will complain that he reduces his waste to the same extent as "6" and would introduce a smaller absolute volume as well but is prejudiced against merely because he chooses to accomplish this result through process changes and dropping certain products from his line rather than constructing "appropriate" treatment facilities "C." Discharger "3" complains among other things that at his location he could introduce 50 units of waste without impairing the quality of the receiving waters below their classification and presents hydrologic data to prove it.

If discharge permits are granted on the basis of a uniform effluent reduction requirement (80%), the results may be arranged as follows:

| | Type of Treatment | | |
|---|---|---|---|
| **% Reduction** | **A** | **B** | **C** |
| 20 | 1<br>U-100 | X | X |
| 50 | 2<br>U-100 | 3<br>U-50 | X |
| 80 | 4<br>S-50 | 5<br>S-20 | 6<br>S-90 |

Here discharger "3" complains that he has a more elaborate treatment facility than does "4" and proposes no greater residual waste loading. Discharger "1" objects because the receiving waters at his location can easily handle his proposed discharge without impairing the standards.

At first glance, one might conclude that, no matter how status discrimination is determined, unsuccessful applicants will always find grounds for complaint and allege unequal treatment under the law. This may be true, but some differences are more easily explained than others in terms of the purposes to be served. For example, the largest industrial discharger cannot reasonably be limited to an allowable loading no larger than the smallest discharger. If he is, he may increase the number of outfalls and apply for several discharge permits. Furthermore, upstream dischargers cannot reasonably claim superior right to discharge wastes into the State's watercourses merely by virtue of their location and irrespective of the needs of downstream users.

There is, however, considerable equity in requiring all dischargers to abate their residual loadings to the same measurable degree. A uniform-treatment process requirement cannot be expected to result in the same percentage effluent reduction for all dischargers. And if the treatment process requirements are modified in individual cases to account for varying circumstances so that parity in effluent reduction results, then it would be much more straightforward to grant permits on this basis to begin with.

### Efficiency

None of the approaches to status discrimination has a built-in mechanism that encourages system-wide economic efficiency. Quite the contrary, under each of the approaches, the Department might find itself requiring measures which result in total treatment costs far exceeding the least-cost solution to obtaining the desired levels of water quality. For example, some dischargers may be able to achieve 100% removal more cheaply than others can achieve 50% removal. If all are required to remove 80% of their generated wastes, the stream standards will not necessarily be obtained at least total cost to the system.

With regard to the costs to individual dischargers, a uniform treatment process approach (treatment standard) is likely to entail greater expenditures than an approach expressed in terms of allowable loadings (effluent standard) or percent reduction. This is true because treatment is only one – and perhaps not the least costly – method to achieve a specified level of waste abatement. Industrial dischargers especially may confront a variety of abatement alternatives, the least costly of which may involve recycling, salvaging, process and product changes, and only minor treatment. Insofar as the Department might undertake to temper the inefficient effects of a rigid treatment standard by allowing abatement by means other than treatment, it will be employing, in effect, an unstated reduction or effluent standard. For example, Section 912a(c) (2) refers to Department approval of waste "abatement or alternative waste disposal" plans as a condition for maintaining a temporary discharge permit. Since the burden of preparing such plans resides with the discharger, one may expect that industrial establishments will seek to minimize the cost associated with approved plans. Thus, in exercising its approval function, the Department has the opportunity to encourage economically efficient responses on the part of individual dischargers, provided complying with a fixed treatment process standard is not compulsory.

### The Risk of Degrading Stream Quality Below Standard

The foregoing discussion has generally assumed that dissatisfaction with the selected approach to permit status determination will be advanced by aggrieved dischargers. It is possible that non-discharging water users may allege that the status determination approach is failing to achieve the levels of water quality required by the stream standards even though all dischargers are complying with the terms of their permits. Such failure might occur simply because the Department had misjudged the effluent loadings that streams can support without degradation, or because the demand for the assimilative use of streams has increased such that when older effluent standards are applied to larger volumes of generated waste, they no longer adequately implement the stream standards. Whatever the cause, such failure will compel the Department to change the basis on which discharge permits are being granted or denied. Moreover, many dischargers who might have undertaken investments in reliance on what they thought the Department would or had approved, may object to such changes, asserting their own good-faith compliance and arguing that the Department is estopped, at least in the short run, by virtue of plans and procedures approved by it.

The problem here is not one of vested rights but rather of reasonable expectations. Section 919 of Act No. 252 makes it clear that a permit granted is not to be construed as a vested right and is "subject to continuing regulations and control by the state." Nonetheless, the alternative approaches to permit status determination do not generate the same expectations. If permits are granted or denied on the basis of a treatment standard (uniform treatment process required), there will be a tendency for permit holders to feel their obligation extends only to complying with such standards including operating practice standards. These permit holders may well expect the State to accept whatever degree of effluent reduction and whatever impact on stream quality results from their compliance.

By contrast, if permits are granted on the basis of percentage effluent reduction, permittees will understand their primary obligation is to achieve this level of reduction regardless of any process and practice requirements the Department may have appended to the permit. Even in this case a permit holder performing the required waste reduction may feel that the State should be prepared to accept whatever impact on stream quality results.

It is only where the State bases a permit grant on direct testing of stream quality that permit holders clearly understand that their obligation does not stop with either an approved treatment process or an approved level of reduction. Here too there are circumstances which a permittee might reasonably claim are beyond the ambit of his responsibility – the water-quality model inaccurate, the assumed hydrology in error, the presence of other dischargers violating the terms of their permits, for example.

In the last analysis the Department must guarantee that stream quality is maintained to standard; in doing so it should place unambiguously on dischargers responsibility for those steps in water-quality management over which they have direct control. Given the data limitations with which the Department must operate initially, it would seem more appropriate to demand specified levels of effluent reduction than to expect compliance only with treatment process and practice standards.

With this substantive evaluation of alternative approaches to permit status determination, we now turn to the mechanics of the information system needed to support both status determination and the pollution charge system, including review of existing discharge reports as background for our recommended information system.

## INITIAL INFORMATION SYSTEM DESIGN

Much of our thinking about system design has been directed toward a computerized operation. Even though initial considerations of time and simplicity suggest that a manual approach should be taken for the first system, we feel that procedures should be selected now with an eye toward eventual mechanization. To this end, we have designed the forms for adaptation to computer processing and have considered what early steps might be taken selectively to automate parts of the initial manual system.

There are three good reasons for eventual computerization of the permit-charge system: (i) to fit a future water-quality model, (ii) to provide accessible data for supplementary analysis; (iii) to reduce administrative and operating costs. Of these reasons, the first is the most compelling for the long run. The value of a computerized water-quality model for planning, surveillance and assessment is generally recognized, and it is expected that such a model will be required for application in Vermont and other states as other water-quality management programs are made operational.

The second point will become more significant as the progress of the Vermont experience is monitored. Much useful new data can come out of this project and we hope that it can be made easily available to all of the agencies that plan to follow the State's progress. The State and the Federal Water Quality Administration should be in a better position to define these supplementary analyses as the demonstration proceeds.

The third point (administrative cost) is fairly minor now because actual data are limited and applicants are few in number. In the future, however, the computer will become a powerful tool for data management and analysis. It seems apparent that the Department can operate with a manual system at the start. If circumstances change and the Department has to deal with many more individual units and changing situations, then it may be well to consider mechanization of much of the work load.

The possibility of developing an automated information system at some future date should not be ruled out, therefore, and it is expected that such systems will become essential for the proper management of larger aspects of State water quality management programs. In particular, the increasing Federal requirements for information in conjunction with such programs as grants for construction of treatment works point out the need for automated information storage and retrieval systems. Also, in view of the wider interests of the Federal Water Quality Administration in this demonstration project, we are prompted to consider opportunities for limited, simple automation where it seems particularly appropriate for the immediate situation. While the present volume of discharge reports does not require automation, the Department may have to consider unincorporated or unsewered areas, and it may wish to keep many more individual records in the future. If so, a simple computerized system can be produced to handle the greater volume of record-keeping.

The design of any information system must first establish the purposes to be served and identify other related uses and systems which may reveal opportunities for merging systems or avoiding redundancies. For the case at hand, the purposes have already been discussed in this and the first Interim Report and need no elaboration here. As to other systems, there are essentially only two – the several manual compilations of data maintained by the Department and the USGS-FWQA computerized streamflow and water-quality file systems. The latter must be ruled out as not appropriate for present direct use by the Department, although it must certainly be kept in mind for subsequent linkage with this and other elements of the information system.

The manual approach is therefore seen as an in-house collection of data to be organized, updated, filed and used by the Department's staff in the immediate future. The data can be broadly classified into those relating to the stream system and those relating to the waste discharger systems. Data pertaining to the stream system, such as low flow volumes and stream classifications, are presently available in the Department's files. Data defining the waste discharger systems will be obtained from the permit application forms.

Several criteria or guidelines were used in the design of the information system. Foremost was the need for simplicity to assure a workable system at an early date. In the case of the permit application forms, it meant that precision and completeness of data were sometimes sacrificed in the interest of developing a reasonable format which would not overwhelm the "average" applicant. It must be assumed that additional information can be requested from the limited number of applicants whose waste generating and treatment systems are so complex as to raise doubts or uncertainties about initially reported information.

While the criterion of simplicity served to place an upper constraint on the level of detail of the data sought, another criterion served as a guide for the lower level constraint. The data base must be adequate to support decisions made by the Department relative to status discrimination and to the calculation of temporary pollution charges, particularly in the event that decisions are appealed for adjudication by the Board or the courts.

In view of the opposing nature of these two criteria, it is evident that the information system must evolve as a compromise – a simple inexpensive system which yet carries the necessary detail to insure reasonable compliance with the basic statute. Our tendency while making decisions within the "grey" area has been to favor the simpler choice in the interest of first developing a reasonably complete basic set of data which can later be expanded as experience is gained. We were of course influenced in this regard by recognition of the inherent limitations imposed by the manual approach to deal with large amounts of data quickly and uniformly.

### Evaluation of Intent to Discharge Reports

Section 910a of 10 V.S.A. requires that

> "Any person who is discharging treated or untreated waste into waters of the state on a regular, intermittent, or continuous basis prior to the effective date of this section and intends to continue such discharges on and after July 1, 1971 shall file a written report of such discharges with the department by September 1, 1970."

We were asked to analyze these reports of Intent to Discharge, together with data available in Department files, for adequacy in supporting various needs of the charge method. Preliminary findings were included in our First Interim Report. At the time, several factors suggested that data contained in the reports of Intent to Discharge should be coded and punched on cards for computer analysis for the following reasons: (i) existing computer services were available from Vermont's Department of Administration; (ii) it was anticipated that a computer simulation model could be utilized for status discrimination analysis; (iii) it was expected that the information system, particularly the accounting and billing operations, would be handled by automated methods; (iv) data available from the reports of Intent to Discharge could serve as a basic foundation for the information system, with additions to be obtained from subsequently required permit application from all dischargers; and (v) ultimate linkage to the federal STORET system was anticipated.

A total of 321 reports of Intent to Discharge were examined and their data entered on punch cards. The data covered all items on the report form as well as supplementary marginal data entered by Department of Water Resources staff. The purpose of including supplementary data on reports of Intent to Discharge was to provide as broad an information base as possible. Data recorded were:

a. name and address of person filing report;

b. location of waste discharging activity (using Vermont town-county code);

c. type and level of activity, including SIC code;

d. daily volume of discharge and estimated daily, weekly, and monthly variation;

e. coded description of treatment facility elements, including type of receiving media (i.e., stream, lake, swamp, groundwater);

f. name of stream or lake receiving the waste discharge;

g. coded trace of river-basins and sub-basins downstream of the discharge;

h. data on stream classification at point of discharge;

i. values of water quality parameters from tests (if available), including suspended and total dissolved solids, turbidity, BOD, pH and temperature.

Two basic programs were written for initial testing and analysis purposes. The COBAL language was used and the runs were made on an IBM 360/40 computer, since these were directly compatible with software and hardware used by the Vermont Department of Administration. The first program was designed to print the input data for each discharger using a common format and table look-up files (i.e., the county and town would be entered using code numbers, but the printout would be in alphabetic format). This printout also included the serial number assigned to each report, date the report was prepared, and any pertinent comments.

The second program was designed for general-purpose sorts and summaries up to third-level discrimination. Two test runs were made, one sorting by county, town, and SIC code, and the other sorting by minor river basin, sub-basin and SIC code. Copies of the printouts from these test runs, the basic coding format, and the reference tables have been furnished to the Department.

During our consultation meeting on October 21st, the Department indicated that it would be premature and perhaps unnecessary to utilize a mechanized and automated system for the immediate future, in view of the limited time available and the expectation that the number of permit applications would be limited to less than 400.[1] As a result, we suspended work on further program development and testing. Nevertheless, the coding work done for the reports of Intent to Discharge proved useful in evaluating the reports and for later designing a permit application form. In fact, coding of any data for computer input is one way of becoming familiar with the data, since one is forced into a rigorously disciplined consideration of data categorization and representation.

The lessons learned from the coding were associated more with the attitudes and abilities of the persons reporting than with the numerical values entered, since the latter were often incomplete or difficult to interpret or adjust to a common format. Specifically, we learned that:

a. Questions should be explicitly phrased to elicit "yes" or "no" or multiple-choice answers wherever possible. Rhetorical answers of any length are likely to create doubts about interpretation and subsequent action on applications for permits.

b. The SIC code alone can be misleading for categorizing waste characteristics. For example, the wastes from a creamery differ from those of a cheese factory yet they would share the same SIC code under the present structure of this coding system.

c. Some persons used separate forms for separate discharges, others combined independent discharges (i.e., process water and cooling water) on the same form. This led to some confusion since single serial numbers were assigned to each form.

d. The distinction between "existing" and "proposed" waste volumes and/or treatment facilities was not always made.

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[1] The question of extending the permit system to some 4000-5000 individual dwellings and small, unsewered commercial establishments was not resolved. The desirability of mechanizing this aspect of the permit-charge system is clear.

e. Essentially no discharger had an accurate idea of the low-flow volume of the stream into which his wastes were discharged.

f. Many forms seemed to have been completed by persons who would not be expected to have technical knowledge of waste volumes or type of treatment facilities, although they may have signed the reports only in their official capacity. This occurrence suggested that it may be useful to include a line in permit application forms for the name of the person(s) who furnish technical data.

g. In one case a municipality submitted a blanket report for all unknown individual discharges. In other cases, municipal reports included storm runoff from combined or storm sewers. This inconsistency led to confusion; for example, a report may have indicated that only 90% of the wastes were treated, but it was uncertain whether this meant that the remaining 10% was due to storm runoff being bypassed or to incomplete sewer collection services. It might also have meant that the sewer treatment plant was inoperative for 10% of the time, due either to maintenance problems or to a trickling filter, frozen part of the year.

h. Discharges were often reported entering swamps, private land or ditches, with some doubts on the part of the discharger whether these constituted "waters of the State," or where such flows entered the waters of the State.

i. There was a distinct time variation in the volume of discharge. Industries, for example, might only discharge five days per week during the day shift; resorts, only during the winter and/or summer; schools would have little or no summer discharge; silt lagoons would only overflow during the spring; gravel washing operations would be shut down during the winter. Nevertheless, the usual volumetric report was simply an average number of gallons per day.

j. In more than one instance, the form was blank except for the name, address, and signature of the reporter. This may have represented a protest but it points out the need for strong statements on the importance of filing subsequent permit applications. It also suggests the need for coordination between federal, State and local environmental authorities seeking discharge data for purposes of developing a common form and reporting frequency.

In addition to these items, the coding operation raised the question of how to indicate the exact location of each discharge on the stream and lake network. The apparent answer is to use the federal STORET system, wherein the exact tributary number and river mile can be coded or the latitude and longitude used for lake discharges. Unfortunately, the basic map coding has not been completed for the State of Vermont and probably will not be for a year or two at the earliest.

As a substitute, we expanded the FWQA river basin coding from the second level to about the fifth level tributary on the basis of streams shown and named on the Department's general map dated March 13, 1970. This provided a fairly precise sub-basin location (e.g., the Jail Branch in Barre), but not an exact river mile within the last level sub-basin. Looking ahead to a water-quality model, it was planned that each discharger within the smallest sub-basin would be assigned a point location code number that would discriminate with respect to his stream location relative to other dischargers.

An entirely separate information component which did not fall within the purview of the reports of Intent to Discharge relates to data needed to calculate the temporary pollution charge. These data will be considered in the next section.

In summary, the early reports of Intent to Discharge provided extremely sketchy information on waste discharge and streamflow characteristics, but at the same time a good introduction to the magnitude and nature of the problem. Also, our own organizing and evaluating work enabled us to lay a good foundation for the application of relatively simple automation techniques that would assist subsequent administration of the permit-charge system.

### Permit Application Form and Related Schedules

A proposed permit application form including related schedules and instructions is included in Appendix D. It is a key element of the initial information system – perhaps the single most important one under the manual concept. The form suggested consists of a basic application page which must be completed for each waste discharging activity conducted by the applicant. An "activity" here is defined as a municipality, a single industrial site, a public institution, or a single residence or commercial building. If the applicant has several dispersed activities, e.g., factories, resorts, restaurants, it is our assumption that he would have to submit separate applications for each activity.

On the basic form the applicant is asked to list each separate, independent waste discharge system associated with the referenced activity. Provision is made for listing six such separate discharges. An independent waste discharge system is defined as one in which raw wastes are collected, treated (or are capable of being treated if no facilities presently exist) and discharged (directly or indirectly) into the waters of the State. Examples of independent discharge systems for municipalities would be unconnected sewer collection systems leading to separate treatment plants, or discharging into streams at separate locations if no treatment plants exist. For industries, independent discharge systems may exist to handle sanitary wastes, process water, and cooling water separately.

As we have structured the application form, the applicant must complete a separate Schedule for each independent discharge system listed on the basic application page. Of necessity, he would have at least one system. There are three types of Schedules available – Schedule A is for use only by municipalities having sewer collection systems, Schedule B for industrial, large institutional and resort dischargers, and Schedule C for residential and commercial discharges from individual buildings and consisting primarily of sanitary wastes.

Each Schedule is in turn divided into two parts. The first part seeks data on the volume and type of waste, the frequency and manner of discharge and the treatment processes. It is thus responsive to § 911a of Title 10 V.S.A. in that it provides the waste discharge system data essential for granting or denying a discharge permit, and a space is provided at the end of part one for the Department to record its decision in this regard.

The second part of the Schedule relates to § 912a of Title 10 V.S.A. and seeks data pertinent to an application for a temporary pollution permit and its associated pollution charge. The applicant may complete the second part of each Schedule at the same time that he completes the first part, and he is encouraged to do so if he believes he cannot qualify for a discharge permit. He must in any event complete part one since only therein are questions regarding the physical parameters which apply to the wastes.[1] The second part is added as an administrative convenience in order to avoid one mailing for the discharge permit application and another for the temporary pollution permit application.

The division of the application permit into a basic activity reporting page with separate two-part Schedules for each independent discharge system has many practical advantages for the Department in addition to providing the least complicated form for applicants. Specifically:

a. Permits will be granted or denied and pollution charges determined on the basis of each separate Schedule submitted rather than on the basic application (activity reporting) form alone. Thus, an industry may receive a discharge permit for its sanitary system and a temporary pollution permit for its cooling water system. Similarly, a municipality may receive a discharge permit for residual effluents from a treatment plant, but not for raw discharges from a remote sewage collecting line that outfalls directly to State waters.

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[1] The streamflow system data, elsewhere available to the Department or assumed to be developable by it by derivation from existing records, will need to be taken into account in a manner dependent upon status determination approaches selected from the choices discussed in the previous section (A above).

b. By the municipal, industrial and residential-commercial separation, the Schedules can be simplified since they will be oriented toward classes of dischargers with perhaps distinctly different information to report. Thus, for municipalities or individual buildings (Schedules A and C) the volume, frequency and nature of the raw waste load can be inferred or derived from data on population served, whereas for industry (Schedule B) these data must be submitted in considerably more detail. Similar distinctions apply to reporting the waste-generation process, pre-treatment activities, and treatment facilities. Since many municipalities will have engineering plans or reports on file with the Department, it will only be necessary to make reference to such plans. Industries, on the other hand, will be obliged to submit detailed data.

c. The small discharger, whether he be an individual householder, inn, restaurant or municipal building, need only complete a Schedule commensurate with his level of activity and opportunity for treatment. The data he will be asked to submit are limited in detail, adequate for the Department's needs, and not likely to create undue citizen annoyance.

The application forms, Schedules and instructions are largely self-explanatory and will not be discussed in detail here; they include accompanying "General Information and Instructions," also presented in Appendix D. Some specific comments on the design follow, including items which should be considered before a final decision to print is taken.

a. *Application Fees:* The format of the schedule for application or "review" fee payments – not to be confused with pollution charge payments – given in the instructions is tentative. Amounts can only be determined on the basis of administrative decisions. The use of variable amounts as a function of the type of Schedule involved and for the processing of part one (discharge permit) as separate from part two (temporary pollution permit) would seem to be as far as one could go in establishing an equitable and administratively feasible schedule. This does not distinguish between levels of activity involved, i.e., a large municipality or industry would pay the same amount as a small one. However, the review time involved can be expected to relate to many factors other than simply the volume of discharge, and since the applicant is expected to enclose the review fee with the application, it is not advisable to establish a complex administrative fee schedule.

b. *Stream Data:* The entire set of data relating to the stream at the point of discharge is assumed to be a responsibility of the Department. The applicant need only indicate the discharge location. While data would of course be entered after the application is received, the Schedule page containing the stream data block should be included in the material furnished to the applicant. Such inclusion assures him that streamflow data will become a part of his application record but that he is not responsible for obtaining it.

c. *Volume, Frequency, and Pollutants for Schedule B — Industrial:* Table B-1 is to be completed by entering the total *volume* of discharge for each approximate eight-hour period, while Table B-2 is to have the maximum concentrations of pollutants associated with the volumes. It may be preferable to request both sets of data in directly comparable form, i.e., average rates of flow for Table B-1, or total pollution loadings for Table B-2. However, while total volume can reasonably be determined and covers industries with highly variable discharges, and while concentration rates can be based on past tests, pollution loads are less likely to be known. Values to be reported in Tables B-1 and B-2 are those after treatment (if any). No space is provided for similar pre-treatment values, but it is expected that such data will be included in the description of the flow system (Item B-4).

d. *Institutional and Resort Wastes:* These are to be reported using Schedule B, but if essentially limited to sanitary wastes, applicants may omit completing Tables B-1 and B-2 by using option A of Item B-5. Here is another way in which the form has been designed for maximum convenience to the applicant.

e. *Temporary Pollution Charge for Industry:* The rate calculation will depend on whether the industry's Federal corporation tax includes a surcharge (i.e., profits above or below $25,000). These data must be obtained in a discreet manner, and the form of the question (part two, Schedule B) should be carefully considered.

f. *Municipal Options:* A rather complex situation may arise with respect to municipal applications, and the forms, Schedules and instructions have been designed to permit flexibility in this regard. The problem can best be illustrated by using examples of increasing complexity:

(1) *No sewage collection system exists.* Assuming also that no Board or Commissioners have convened to take action on a future system, the municipality here will not use Schedule A. Each individual discharger will be responsible for filing his own application and Schedule C. Discharges from a municipal building will require a permit application from the municipality, but also using a Schedule C.

(2) *A municipal sewage collection system exists with no extraordinary users existing or proposed.* The municipality will apply using Schedule A. The Schedule does ask for general information about dischargers located within the boundaries of the municipal corporation who do not use the collection system; however, it will be the responsibility of such persons to submit separate applications with a Schedule C.

(3) *A municipal sewage collection system exists with extraordinary existing users.* These users will typically be industries contributing a substantial volume of wastes (say 5% or more of the total) or discharging unusual pollutants into the municipal sewer system. The municipality will submit Schedule A and describe such discharges in the spaces provided. This information will permit the Department to estimate waste volumes and constituents on the basis of population served, with adjustment for the extraordinary system users.

(4) *Same as the last two cases above, but with proposed additional users to be added to the system after July 1, 1971.* The new users may be a group of residences along a presently unserviced street, or an industry. Assuming that these new users are presently discharging into waters of the State, it will be their responsibility to apply for individual permits pending tie-in to the municipal system. However, they will report their proposed plan for treatment as discharging into a proposed new or extended municipal collection system.

The forms are designed to accommodate individual filing or group filing and thus permit the Department to select the conditions under which group filing will be accepted.

g. *Description of waste generating flow sequence including treatment facilities:* It will be essential to know the volume, frequency and characteristics of the waste discharges prior to treatment in order to evaluate the efficiency of the treatment process. The treatment process must also be described in sufficient detail to enable an engineer to approve the treatment process and determine whether the applicant qualifies for a discharge permit.

In designing the application forms, we have not included a fully comprehensive set of questions regarding pre-waste treatment operations or calling for a description of treatment facilities. In Schedules A and C and Option 1 of Schedule B, the waste generation can be inferred from population served. The treatment facilities in these cases will most probably be standard units for treating sanitary wastes and can either be described in simple terms or by use of engineering reports or plans. With regard to industrial waste classification with its widely diverse waste generating and treating processes, we suggest that pertinent engineering reports and flow charts be submitted as attachments (Item B-4, Schedule B) rather than a form designed to cover all possible situations.

h. *Comprehensive coverage:* The schedules are designed to apply to any expected type of waste generating activity. Schedule B, while oriented toward industrial and large institutional or resort operations, can be used to cover a greater variety of cases. Schedule C is a short form of Schedule B. Schedule A resembles Schedule B but includes questions concerning municipal funding and grants.

In summary, the design of the permit application forms involved compromises between technical completeness and simplicity. We attempted to favor the latter since the Department may always seek additional information. Since the Department's staff is generally familiar with the dischargers in the State, there should be little difficulty in determining whether any applicant is intentionally or unintentionally withholding any pertinent information.

### Surface Water Information

The initial surface water information consists of two classifications – physical data as represented by flow volumes and quality parameters, and administrative data represented primarily by stream classifications. Before considering the data elements required for each classification, it should be noted that the surface water system can be viewed in two contexts, the first consisting of data applicable only to the locations on the system where discharges occur, and the second consisting of data and functional relations which define and describe the State's entire surface water system independently of the discharges.

Data relating to stream classifications originate in the classification orders, or in statutes for streams not otherwise classified. Since the classifications apply to a set of stream reaches or lakes which cover the entire State, these data are readily adaptable for use in a general purpose system (i.e., stream classifications, once established, are independent of discharges although subject to periodic change).

Data defining the physical system are based on a limited number of gaging station records of flow volumes and on an even more limited set of sample reports of quality parameters. To apply these data to other stream locations, whether to specific discharge points or to any point, requires a knowledge of the way streams are used and in particular, the way in which dams are operated.

Critically important low-flow statistics may change as a result of new facilities, construction, changes in withdrawal rates, or changes in operating procedures. The amount of such change depends on the nature of the low-flow statistic involved. For example, the flow exceeded 98% of the time (based on average daily flow rates) may have the same value as the 7-day, 10-year expected flow in one location but not another, depending on the method of regulation. If one considers flow rates on an hourly or instantaneous basis, the statistical values may change again.

Quality measurements are subject to even greater change. If raw waste generation remains constant as treatment facilities are installed, the stream quality should improve, but if raw loads increase, the estimation of future stream quality on the basis of past samples may be misleading. Carrying the past into the future is usually complicated but should be manageable. In addition, it is necessary to interpolate for space points or locations that have not been gaged. For streamflow, this is normally handled by use of ratio of drainage areas and cross-correlation; but this technique is subject to errors if the flows are subject to regulation. Pollution loadings, unlike streamflows, cannot be expected to vary linearly with the drainage area, particularly with respect to biodegradable parameters. Although some broad estimates can be made, an accurate portrayal must await a detailed model.

Problems relating to the establishment and use of a surface water information system are, of course, more numerous and complex than indicated above, and the Department's staff is well aware of the scope and detail involved. However, without further elaboration, we list these conclusions:

a. The surface water information system, however it evolves, will have to provide reasonable estimates of future conditions, since permits will apply to future and not to present conditions.

b. To accomplish this, the systems must deal with time and space and be able to project the future as well as to fill in for missing points in space.

c. The system could emerge in one of two forms – a general-purpose system using a computer for data storage, retrieval and transformation, or a simple special-purpose system using manual methods.

The manual approach is the only one which can be accommodated under limited time and least-cost constraints. However, in adopting this approach it should be realized that a good deal of professional judgment will be required in making estimates. The manual surface water information system will contain only data items now available to the Department. There is, in fact, no time to augment this data base prior to the time when it will have to be used for permit discrimination and treatment facility evaluation. As each application is considered, surface water data will have to be retrieved and evaluated by the Department.

There is little point to building an elaborate cross reference or interpolation system to support the manually kept files of streamflow data. In keeping with the desire for simplicity, we suggest that streamflow files be kept in geographic location order.

### Use of the System

The key parts of the information system are the permit application forms and surface water records. In the process of using the system a third class of information will evolve which can be defined as that containing the Department's decisions, accounting and billing information, and reporting information (e.g., revenue forecasts). These derived results are described below.

#### Granting of Permits

Upon receiving an application, the date and serial number should be entered on the basic application form and all Schedules. The number of Schedules and the amount of fee payment enclosed should also be noted on the basic form. A file folder, identified by serial number should then be established to store all papers relating to that application. The application review check should be listed on a daily receipts form and transmitted, with all others, to the Department of Administration. Finally, the name of the applicant should be entered on a Departmental "permit status log" using separate line entries for each Schedule. All of this work can be accomplished by a secretary or file clerk.

The Department log of permit status will also serve for generating reports. Each line will represent a submitted Schedule and will have several columns in which the results of various decisions, actions, key data, and dates can be entered. Whether the log is kept on single large accounting sheets or in sets of books is a matter of personal preference.

The next processing operation will require an engineer to examine the application and appended Schedules to determine whether sufficient data have been provided. If few additional data are needed, they can be requested by telephone and, if furnished, can be entered on the form with a note to this effect. If a significant amount of new data is required, it should be requested in writing. These actions and pertinent dates should be entered on the status log; if the original data are sufficient, this fact should also be noted.

The next step will require someone to plot the discharge location on a map. The block on the Schedule containing the stream data can also be completed, using tentative estimates of future flow rates.

On the basis of data thus far assembled, it should be possible to reach a decision to either grant or deny a discharge permit. The decision should be noted in the appropriate block on the Schedule form and on the status log. If the reasons for the decision are not evident, an explanatory finding sheet can be added to the file.

If a discharge permit is granted, all that remains is for said permit to be transmitted to the applicant. A copy of the application form can be attached to and considered a part of the permit. The expiration date must, of course, be included. If a discharge permit is denied, the applicant should be notified by letter with his attention called to his appeal rights and to his option to apply for a temporary pollution permit as explained in the general instruction sheet. If he wishes to apply for the temporary pollution permit, he should complete the items in the second part of the Schedule (if he has not already done so), and he should submit an additional application review fee.

The applicant has other choices than appealing or applying for a temporary pollution permit. He may also amend and resubmit his application or he may "quit," that is, go out of business or attempt to discharge without a permit. He can apply these options at almost any time in the overall procedures, and in the event that he is denied a temporary pollution permit after all appeals, these are his only choices.

The amendment option has received little attention but could become a much used course of action for Schedule B and C discharges. This could be particularly true during the period prior to July 1, 1971, since the applicant need only describe the treatment facilities which he expects to have operational on that date. As long as he can act quickly, he would logically try to qualify for the discharge permit. If he failed on the first submittal, an amended application for a discharge permit may be his optimal strategy.

The processing of applications for temporary pollution permits should proceed in the same manner as the processing of discharge permit applications. The status log should have additional columns for the estimated completion dates of various phases of treatment facility construction, to serve forecasting purposes, and a column in which to indicate the expiration date of the temporary permit.

### Accounting and Billing

The entire accounting process is quite simple and the Department has indicated that it is equipped to operate it initially on a manual basis. The status log sheet serves as a journal and the application files as a ledger, thus providing an easily established and low-cost manual system which should suffice if the number of permits is about 400 and need renewal only on an annual basis. As experience is gained during the first year's trial period, it will be possible to modify and expand the accounting system and possibly to adapt it for simple automation.

Billing will only be required after a decision has been made to grant a temporary pollution permit. Before the permit is granted, the applicant should be notified and a bill sent to cover the pollution charge.

## PRELIMINARY NOTE ON COMPUTERIZED MODELING FOR SUBSEQUENT STATUS DETERMINATION AND OTHER OPERATIONAL PURPOSES

Status determination and other operational functions can be made technically more precise when better data and analytic capability become available from the information system. This can best be explained by considering how the task might be approached under no time or budgetary constraints.

The logical analytical tool would be a mathematical simulation program for modeling the surface flows in a river basin, including their quality components. The stream network would be divided into a set of reaches, with a new reach starting at any point at which there is a significant change of state in the real-world system, for example at stream confluences, dams, waterfalls, at each waste discharge point, and wherever the stream classification changes. The next step would be to develop hydrologic routines to represent the flow volumes and their natural quality components added to each reach, and routing equations to accumulate and transmit these values downstream. The nature of these routines would depend on the time interval selected (i.e., one hour, one day, one month), but such routines could be developed with some use of simplifying assumptions regarding the DO and heat parameters. The hydrologic input could be stochastic for a dynamic analysis or it could be fixed at some low-flow value for a steady-state analysis, such as the average 7-day, 10-year flows. We assume that the model would represent a steady-state condition.

The computer program would operate by starting at the uppermost reach (headwaters), with the computations proceeding downstream and picking up tributary streams as appropriate. Whenever the computations reached a point of waste discharge, its volume and load would be added to the stream values by assuming that complete mixing occurred. The resulting stream quality for non-degradable pollutants could then be compared to the standards applicable to the reach. If the stream quality prior to the discharge were above standard and that after discharge below standard, the effluent evidently causes degradation, and a message to this effect could be printed out.

The degradable pollutants, principally BOD and heat, require additional routines to account for the assimilative capacity of the stream. Unless there were several sources of heat discharge in close proximity, it could be assumed that stream temperature returned to ambient prior to each new discharge. In this case the heat load could be evaluated by assuming complete mixing at the point of discharge and comparing the resulting river temperature to the standards. No heat load would be carried downstream. In the event of several heat discharges in close proximity, the reach or reaches involved would have to be evaluated separately.

The effect of BOD discharge could be modeled under several assumptions. One would be to calculate the DO profile downstream of the discharge point using two load conditions, the first being the stream loading before the discharge was added, the second after the discharge was added. The DO values would then be compared to the reach standards to determine whether the discharge was responsible for degradation. The program would make this determination on a purely mathematical basis and print out the names of the dischargers whose effluent resulted in stream degradation.

The simulation analysis would be run several times to develop a complete set of information. The first run, for example, could use the existing effluent load from each discharger, whether treated or untreated. The results would represent stream quality occurring under low-flow conditions. But this may result in some downstream dischargers being flagged as polluters because of the load from upstream polluters. To adjust for this, a second run would be made in which the program would "halt" whenever a discharge which caused stream degradation was discovered. Now input cards would then be added to reflect the waste load which would occur after acceptable treatment facilities had been installed. The program would then resume the calculations, moving downstream but carrying only the after-treatment loadings. Thus, each new discharge would be examined under the assumption that all upstream dischargers had been adequately treated.

Similar runs could be made using subroutines which simulated the treatment process for each waste generator. In this case the input data would be the raw waste volume and concentration and values to describe the treatment process. The subroutine would then determine the treated effluent load for use as input to the stream model. Additional subroutines could be developed to calculate the raw waste loads, using population or industrial production values as input.

It would be technically possible to develop such a program along the lines described, but not before decisions are needed for the administration of the law. Furthermore, the present stream classification criteria are not as specific as would be necessary for a mathematical model. For example, the polluting loads caused by natural sources are not applicable to the criteria, but they would have to be included for the purpose of calibrating the model. This would require use of dual stream-quality vectors in the program and dual printout, one representing the physical system as it truly exists and the other representing the system under the influence of point source discharger loads only.

The criteria are also vague in that the maximum allowable concentrations of several pollutants are expressed in performance terms, e.g., "none in such concentrations that would impair any usages specifically assigned to this class," or "that may result only from appropriately treated effluents provided it does not cause a violation of the classification of contiguous waters," where "appropriate" is defined as "secondary with disinfection or the industrial equivalent unless a lesser degree does not degrade the stream classification."

Presently, therefore, the information system requirements are primarily related to data describing the waste load. These can be obtained from treatment plant design documents, or if no treatment exists, from population data or test results. Other data required are stream classifications, which are presently available, and low flow volumes. The latter can be estimated by the ratio of drainage area method, based on existing gaging stations for which low-flow statistics are available from U.S. Geological Survey analyses.

## SUPPORTING ADMINISTRATIVE PROCEDURES

### Responsibility for Effluent and Stream Related Data

Starting up and operating the effluent charge system basically requires two kinds of data: (i) effluent data, which describe the volume and pollutional loading characteristics of the effluent emanating from each discharger, and (ii) stream data, which includes both hydrologic and stream quality data. As evident in the suggested application for permit forms, we believe that the individual discharger should be made responsible for reporting the characteristics of his waste discharge. The parameters to be reported on the permit application, including the time variability of the discharge, have been described in Section B and in Appendix D. In addition, each discharger should be required to report to the State whenever his discharge exceeds that initially reported. Surveillance should be maintained by the State through regular on-site spot checks of effluent quality and treatment practice.

Stream-related data, including both flow and quality data, should be the responsibility of the State. These are of basic importance initially and to the future overall water quality program of the State, and individual dischargers cannot reasonably be expected to maintain the required data-gathering process. Large amounts of flow data are already available to the State. Addition of further measurement stations, both for flow and quality, must be planned to serve the State's overall needs.

A host of additional supporting administrative functions are of immediate or near-term importance to effective operation of the system. Among these, we have considered with the Department only those which must be anticipated early in the operational phase, and for which some preparatory planning over the next six months must be made. Surveillance and monitoring of all discharge activities will require organizing because of the implications for permit status changes and compliance with initial status determinations and discharger response. Only the most preliminary estimates of budget requirements and revenue forecasting are possible in advance of resolving the separation of dischargers between discharge permit holders and temporary pollution permit holders.

### Compliance Test Procedures

Compliance tests will consist of field inspections of waste-producing activities and treatment facilities, and the taking of effluent samples. In the case of municipal treatment plants, field data can be compared to expected values indicated by the approved engineering plans and specifications. This procedure should also apply to industrial facilities for which plans have been submitted and approved. In addition, flow volumes and waste concentrations as reported by the applicant in Tables B-1 and B-2 can be used as comparison criteria. Since the applicant is asked to indicate maximum flow volumes and waste concentrations, and since the Department's decision regarding permit status will have been based on these values, test volumes or concentrations in excess of these values immediately signify non-compliance.

Compliance testing related to temporary pollution permits will vary according to the terms of the permit. In the case of discharges reported on Schedules A and C, little will probably be accomplished by way of interim treatment, and the principal objective of the compliance inspection should be to assure that the discharger is progressing on schedule to install treatment facilities. Progress of industrial dischargers should also be examined, whether for plant construction or research. In addition, interim treatment measures should be examined, samples taken, and any records which the discharger is required to maintain should be reviewed.

Summary reports of compliance tests can be prepared and added to the permit file by Departmental staff engineers who are assigned to this function. The date of the test and indication of the results can be entered on the status log sheet. This again represents an extremely simple administrative procedure, but it should be adequate for the initial period.

### Forecasting of Revenues

Revenues will come from two sources, the application fees and the temporary pollution charges. The former are mainly associated with initial review and start-up and will be less significant thereafter. Temporary pollution charges can be expected to generate the greatest revenue during the first year, after which such revenues will decrease as temporary pollution permittees come into compliance and qualify for discharge permits.

Revenues can be estimated from the status log sheet. For each temporary pollution permit the dates will be recorded when certain phases of abatement are scheduled, and also the total amount of expenditures made by the permittee. A separate calculation can then be made for each year of a five or more year projection period, using the original temporary pollution charge amount as a base and giving whatever credit is selected for interim progress. The sum of these amounts, together with the sum of the renewal charges, will represent revenue forecasts.

This simple manual technique requires the use of judgment when considering each discharge. As long as the total number of temporary pollution permittees is small and the staff member assigned to the work is generally familiar with the overall situation, the method should prove satisfactory. Some new dischargers can be expected to appear each year, and they will be included in the calculations as they submit applications. It does not seem advisable to attempt to anticipate such new dischargers at the present time. We have assumed for preliminary budget estimating purposes that roughly one half, or 200, applicants may come under the status of temporary pollution permittees.

The individualized nature of the approach to charge structure and schedules is not readily amenable to automated forecasting but some techniques can be developed to produce a reasonable range of projections. Revenues will vary also according to administrative decisions on effecting short-term, as distinct from long-term incentives, as discussed in Part Two of this report.

### Changes in Permit Classification

We have assumed that all permits will be reviewed annually. During the initial phase (i.e., the first year), the review or renewal dates for discharge permits may be staggered to spread the load of reviewing permits by setting the expiration date of all applications having a serial number ending in "1" for January, etc., thus skipping two months of the year. Note, however, that the temporary pollution permit has a limited life which is to be set by the Department after due consideration of each case.

If at any time it is found that a discharge covered by a discharge permit is not in compliance and immediate remedial action is not or cannot be accomplished, the permit should be revoked and the discharger required to apply for a temporary pollution permit. The associated charge should first be calculated as an annual rate, but the bill should be based on a monthly rate and retroactive to the time the violation was discovered.

In the case of temporary pollution permit holders who have completed a major segment of their corrective program, a similar calculation will be involved. The procedure should allow the discharger to submit an amended application when the action has been completed. This application can then be processed in the normal manner, but the new permit (if granted) will contain a statement voiding the old permit. The Department may decide to grant retroactive credit for such steps as have been taken, or it may decide to change charges only as new applications are filed, processed and approved.

### Changes in Compliance Testing

During the operation of the program, changes will occur in the overall management of the State's water quality program which will affect the compliance testing process and needs. Some of these changes will be due to factors external to conditions which existed when the discharger prepared his initial application and the permit was issued. For example, new federal regulations or forms may be developed (e.g., recent changes to Title 18, Section 601, or FWQA test form 120), or the stream standards may be revised to include new parameters. Either of these situations may require that a stricter or more detailed compliance test be conducted, or that the discharger install more monitoring equipment or increase the frequency or sampling.

The manual information system can be readily modified to accommodate these as well as other changes, but certain precepts must be considered. First, the annual period recommended for permit duration would seem to be a sufficiently short time so that no administrative changes need be made except under extraordinary circumstances. Thus, once the applicant and the Department have come to a meeting of the minds as expressed in the permit, the conditions stipulated, including any compliance testing on the part of the applicant, should remain fixed for the duration of the permit.

If, however, it is expected that compliance testing needs will change rapidly with respect to increasing detail, complexity or frequency (and hence become more costly), it may be preferable to have all permits expire on the same day rather than on distributed months as previously suggested. While peaking in the administrative work load will occur, greater equity for dischargers will result since they will all confront increased requirements at the same time. It will also be easier to develop automated surveillance programs if new testing criteria are applied to all dischargers at the same date. These several administrative considerations will warrant close, continuing examination and a flexibility of responsive actions by the Department before and during the first year of operations of the permit-charge system. The consultants' services will prove useful during the consultative phase and Phase II for these purposes.

## Staffing and Budget Requirements and Time Schedules

We make the distinction in this section between schedules to be followed and the Department's requirements for staff and budget during the start up period, discussed as "Start-up Period," and the annual requirements for operating and maintaining the system after start-up, discussed as "System Operation." These estimates are quite preliminary and represent minimum basic staff requirements only under the present circumstances of uncertainty concerning decisions on charge schedules and status eligibility of permit applicants.

### Start-up Period

The effluent charge system will be made ready for operation during the period from January 1 through June 30, 1971. In order that the applications for permits can be given proper consideration, the following schedule of events is proposed:

| | |
|---|---|
| Jan. 1, 1971 | Begin hearings. Publicize application requirements following completion of hearings. |
| Feb. 1 | Send out application forms to prospective applicants. |
| Mar. 1 | Discharge permit applications due. Collect application fees. File, cross index, and process applications. |
| Mar. 15 | Notify applicants of decisions. Specify application procedures for temporary permit. |
| April 15 | Temporary permit applications due. Collect application fees. File, cross index, and process applications. |
| May 15 | Notify applicants and publish intent to grant temporary permits. Receive written objections. Compute fees. |
| June 15 | Review permit conditions and revise as required. Formally issue temporary permits. |

For the purpose of estimating staff and budget requirements during this period, we assume that approximately 400 major dischargers will file for permits. On the basis of the September 1970 Intent to Discharge reports, we can roughly estimate that about one half of the applicants will receive discharge permits and the other half temporary permits. Most of the effort will be centered in the Department's offices, with field visits to some temporary permit holders likely.[1] The minimum requirements are estimated as follows:

1. Mailing of application forms to 400 applicants. 100 hours of clerical time at $3.50 per hour. – *$350.*

2. Processing of 400 applications; filing, handling of enclosed fee, "yes-no" decision on granting of discharge permit. About 200 hours of clerical time at $3.50 per hour – $700; 100 hours of professional time at $8 per hour – $800. Total *$1,500.*

3. For the 200 applicants not granted discharge permits, specification of allowable effluent loading (e.g., pounds BOD per day, etc.) and specification of type of treatment desired. About 100 hours of professional time at $8 per hour – *$800.*

4. Notification of all 400 applicants as to decision. About 100 hours of clerical time at $3.50 per hour – *$350.*

5. Processing of 200 applications for temporary permit; filing and handling of fee; review of proposed plans and discussion with those dischargers whose plans are unacceptable.[2] About 50 hours of clerical time at $3.50 per hour – $175; about 400 hours of professional time at $8 per hour (including visits to approximately 20 dischargers) – $3,200. Total – *$3,375.*

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[1] Department personnel have estimated that perhaps 20 doubtful cases may require field visits.

[2] The fact that provision on Schedules is made for application for temporary pollution permits may expedite processing and reduce costs.

6. Notification of applicants as to intended action; publication of intended action; receiving and review of written objections; review of permit conditions. About 200 hours of professional time at $8 per hour – $1,600; about 100 hours of clerical time at $3.50 per hour – $350. Total *$1,950.*

7. Computation of individual fees; formal granting of temporary permits. About 100 hours of professional time at $8 per hour – $800; 50 clerical hours at $3.50 per hour – $175. Total *$975.*

Requirements for these seven phases plus a contingency estimate are summarized below.

| | Man Hours | | Cost | | |
|---|---|---|---|---|---|
| Phase | Clerical | Professional | Clerical | Professional | Total |
| 1 | 100 | -- | $ 350 | $ – | $ 350 |
| 2 | 200 | 100 | 700 | 800 | 1,500 |
| 3 | – | 100 | – | 800 | 800 |
| 4 | 100 | – | 350 | – | 350 |
| 5 | 50 | 400 | 175 | 3,200 | 3,375 |
| 6 | 100 | 200 | 350 | 1,600 | 1,950 |
| 7 | 50 | 100 | 175 | 800 | 975 |
| Totals | 600 | 900 | $ 2,100 | $ 7,200 | $ 9,300 |
| Contingency (25% of estimate) | | | | | 2,325 |
| | | | | | $ 11,625 |

The most concentrated initial effort will be required in Phases 2, 3 and 4 and later in Phases 5 and 6. According to the suggested schedule given above, Phases 2, 3 and 4 must be accomplished within two weeks (March 1 to March 15). Assuming 40 man hours per man week, 300/80 or almost 4 full-time clerical people will be needed and 200/80 or about 2½ full-time professional people. Phases 5 and 6 must be accomplished within one month (April 15 to May 15), so that the requirements in this period are for 150/160 or one full-time clerical person and 600/160 or nearly four full-time professional people.

The staffing and budget estimates do not include any allowance for supervisory personnel under the assumption that their time would be charged to general operating accounts. Also, it was assumed that the review of plans for treatment plants submitted by municipalities would be charged as part of the cost of administering the construction grants programs. If these supervisory and review costs were to be charged to the permit account, the staffing and budget estimates would have to be increased considerably from the values given.

### System Operation

Regular operation of the system will require both office and field work. Office work will be made up mainly of billing, receiving and handling payments, and updating permits and adjusting fees in individual cases. On a yearly basis, the requirements are estimated to be:

| | |
|---|---|
| Billing; receiving and handling payments on a quarterly basis – 200 clerical hours at $3.50 per hour | $ 700 |
| Updating permits and adjusting fees – 50 clerical hours at $3.50 – $175; 100 professional hours at $8 – $800 | 975 |
| Total Office Cost | $1,675 |

Field work will consist mainly of spot checking dischargers' performance. Holders of regular discharge permits and temporary permits should be checked at irregular intervals. Effluent samples should be taken and the operation of abatement facilities inspected. Assuming that 800 inspections must be made per year, and that each inspection team can make two inspections per day, 400 team-days are required. This corresponds to two teams on the road all year around. (Alternatively one team might be used year around, with added teams put into the field during the summer months.) Assuming that each inspection team is composed of one professional engineer and one helper, the estimated cost per team is:

| | |
|---|---|
| Salaries and benefits | $24,000 |
| Expenses | 8,000 |
| Equipment and supplies | 4,000 |
| | $36,000 per year |

The annual cost of field surveillance with two equivalent full-time teams is $72,000. This may not be a net additional cost, since other existing field surveillance activities may suffice to cover at least part of the charge system activity.

The total annual cost of maintaining the effluent charge system is therefore approximately $74,000. A contingency of 25 percent should again be applied, raising the budgeted estimated to $92,500, all as qualified by the inherent uncertainties associated with the number of discharges over which surveillance will be required.

# APPENDIX A

## VERMONT WATER LAW AS DEVELOPED BY PRECEDENT

### INTRODUCTION

The following is a sampler of Vermont water law cases which illustrate the common law case-by-case development of a scheme for allocating competing uses of Vermont's waterways. As indicated elsewhere the new provisions of Vermont's 1969 Water Pollution Control statute are not meant to "impair or abridge the right of riparian or littoral owners or others to sue for damages or injunctions or exercise any other common law or statutory remedy to abate and receiver damages for water pollution." While it is thus clear that the rights of "downstream" users are not to be reduced, it is not clear whether the operation of the law may affect such rights by way of enhancement. Conversely, may the statute impair the common law rights of dischargers to reasonable use of the water's assimilative and transport capacity? The statute is strangely – or significantly – mute on this point. Nonetheless one can easily hypothesize a situation in which action of the Water Resources Board or Department would appear to impair a discharger's common law right to reasonable use. What is the shape or legal quality of such a right? The cases below give some guidance.

An additional comment is necessary to relate the present section to our effort in Vermont. Historically there was only one basic mechanism for allocating the various uses of a watercourse as among competing riparians. This mechanism was the common law which decided only one dispute at a time and, by and large, assigned and protected rights as among riparians but did not determine rights as between riparians and any state administrative agency. The 1969 Vermont Water Pollution Act superimposed a new mechanism for allocating water uses via stream classification, Department discharge and pollution permits, effluent fees and Board orders. Please note that the common law mechanism has not been replaced but merely supplemented by direct, state administrative and quasi-judicial regulation on behalf of the people at large as well as riparians.

Inevitably conflicts will arise in which a defendant-discharger in a private nuisance action will raise one of two defenses: (1) the administrative agency has *exclusive* jurisdiction and the defendant is discharging in compliance with an administrative order and, therefore, there is no private common law cause of action or (2) the administrative agency has *primary* jurisdiction and the plaintiff's *legal* action is premature because he has not exhausted his *administrative* remedies. The statute anticipates this possibility and clearly states that plaintiffs have not lost any of their legal remedies.

There is another circumstance, however, in which a conflict may arise between the common law mechanism and the administrative regulatory mechanism. Here a plaintiff may claim that while an upstream discharger is making a "reasonable use" of a waterway as that term was understood in past common law cases, the discharger is now violating an administrative order which order creates new grounds for *legal* relief on behalf of plaintiff. In this situation the court of law has three choices: (1) the court can agree that violation of an administrative order gives injured riparians a new cause for legal remedy in a private nuisance suit; or (2) the court can claim that administrative orders do not create any new remedies for aggrieved riparians in private actions or; (3) the court can assert that the very concept of what constitutes a "reasonable use" has been affected by administrative reclassifications and orders so that while no new remedies as such are created, a heretofore "reasonable use" has become unreasonable in the light of changed circumstances. The results in (1) and (3) are the same despite the different legal theory employed. We make no conjecture as to what the Vermont Supreme Court might do in such a case. If injunctive relief were granted, private actions might compel compliance with administrative orders where administrative enforcement was not forthcoming or simply slow.

In large measure these concerns are beyond the scope of our immediate task except insofar as Water Resources Board and Department activity will be informed by the traditional approaches and insofar as some reluctance may be encountered to any effluent fee system which is radically at variance with the common law's loose "balancing of conveniences" technique unless clear reason is articulated for such variance.

## BRIEFS OF CASES

### Case #1 *Martin* v. *Bigelow,* II Aikens 184 (Vermont 1827)

Motion for new trial granted in an action in trespass where defendant sawmill owner and prior water user entered on plaintiff's land and removed his recently constructed upstream mill dam. The Court rejects common law doctrine that a prior-appropriating actual user has an action for any diversion of water to his injury as inapplicable in Vermont (statute adopting common law gives it power to say how far it is applicable). Instead where upstream user is not diverting from the channel and is not wantonly wasting, mere prior occupancy does not give the downstream user the right to prevent upstream user from using some water in a prudent way. [Six years after this case the English Courts accepted the riparian doctrine in favor of that of prior appropriation.] [The question of prescriptive rights after 15 years was delibertately left open.]

**Case #2** *Snow* v. *Parsons*, 28 Vt. 459 (1856)

Action for damages by downstream saw mill owner against upstream latter-constructed tannery caused by obstruction of plaintiff's water wheel by the *tanning-bark* discharged by defendant's tannery and allowed to float down one and one-half miles to plaintiff's mill. Judgment for the plaintiff on referee's report was reversed and the case remanded for trial on the facts offered regarding the necessity for tanners to dispose of tanning bark and its customariness.

The court observed that riparians have the right to use waters for manufacturing purposes including disposal, but "the reasonableness of such use must determine the right, and this must depend upon the extent of detriment to the riparian proprietors below . . . An extent or kind of deposit, which might be of no account in some streams, might seriously affect the usefulness of others. Within reasonable limits, those who have a common interest in the use of air and running water, must submit to small inconveniences to afford a disproportionate advantage to others. It seems to us that this question of the reasonableness of the use of a stream, when it is not settled by custom, and is in its nature doubtful, should always be regarded *as one of fact*, to be determined by the tribunal trying the facts." (emphasis added)

**Case #3** *Jacob* v. *Allard*, 42 Vt. 303 (1869)

Bill in equity by downstream starch mill owner against upstream shingle mill owner for discharging shingle sawdust which renders the water impure and unfit for making starch, claiming this was done with an intent to injure plaintiff. The decree for plaintiff was reversed because no evidence of malice in case and the use was a reasonable one, the plaintiff being able to avoid the nuisance by means of small expense of his own for purification equipment.

**Case #4** *Canfield* v. *Andrew*, 54 Vt. 1 (1882)

Suit to enjoin an upstream defendant from diverting water, ponding and disposing of sawdust in a river which fouled plaintiff's dam and mill works.

Held the diverting and ponding were reasonable and therefore injunction denied; regarding the disposal, the court said " one may use one's own property so as not to injure that of another." Moreover, "Such damages as are incident to, and necessarily result from, a proper use of the water must be borne; but the manufacturer has no right to do an act that in its consequences is injurious to other because it is a matter of convenience or economy for him to do it. [One may query whether the reasoning here is altogether consistent with *Snow* v. *Parsons*.]

## Case #5 *Laurie* v. *Silsby* 76 Vt. 240 (1903)

Suit for injunction by downstream riparian and his non-riparian grantees against upstream riparian who built a trout pond with result that flow of water was reduced and the quality degraded. Grantees-plaintiff had built an aquaduct over plaintiff-riparian's land to pipe water for farms at his license forty years ago.

Court holds plaintiffs have no prescriptive rights against defendant (although the "long-continued enjoyment" had been sufficiently long) because such presumption of grant arises only when the person against whom the right is claimed could have lawfully interrupted or prevented the exercise of the subject of the supposed grant, which defendant could not have done here because the plaintiff's taking of the water did not infringe their rights (no harm done).

Held: plaintiff-grantees have standing although non-riparians because such riparian rights to use are grantable or assignable.

Court states that the legal quality of correlative riparian rights is that each proprietor "must use his own right so as not to deprive the others of an equal enjoyment of their same rights." Thus reasonable use is the only limit set on exercise of these rights and it becomes a question of fact whether use made by a riparian owner for his own purpose *OR* for sale to others for non-riparian purpose is a reasonable use.

Here plaintiff's use is deemed as a matter of law reasonable against defendant because the use was lawful and beneficial and occasioned no harm. However, defendant's use does damage plaintiff and therefore as a matter of *law* cannot be deemed a reasonable use and therefore is a question of fact for the master. Reversed and case remanded.

## Case #6 *Board of Health* v. *Village of St. Johnsbury* 82 Vt. 276 (1909)

Bill in chancery to enforce an order prohibiting the furnishing and the use of the village water supply for domestic purposes "till such time" due to pollution. Judgment enforcing the order was granted and reversed on appeal because the statute giving the court permission to enforce orders does not make such orders final and conclusive so as to deprive parties affected of a right to a hearing before the court. Issue raised by defendent was that Board could not effectually enforce the order, i.e., it could stop village from pumping water into its mains but could not distinguish use for laundry and flushing purposes and domestic use, the former being expressly permitted.[1]

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[1] In *McCormick* v. *Russel*, 172 Pa. 506 it was stated that the State might require a municipality to supply water of a set quality or cease collecting charges therefore and could require it to be diligent in seeking a new supply of pure water, but the State could not require the company to relocate its plant or seek a new supply, to reach which would involve an expense greater than its entire capital stock.

Case #7 *State* v. *Morse* 84 Vt. 387, (1911)

Conviction of bathing in Montpelier's water supply (Berlin Pond) in violation of order promulgated to protect water until Montpelier could construct purification facility. No actual notice was received but notice through posting as required by statute was given.

On appeal the conviction was sustained and execution ordered, the Court pointing out that where the statute makes provision for giving notice and this is complied with, no actual notice to the defendant is required to make the order binding. In discussing the proper exercise of the police power the Court observed:

> "That a riparian owner has a right to the reasonable use of the water of such a pond, we agree, that this ordinarily carries the right to bathe and swim therein we agree; that this right is a property right, we agree . . . . Can it be said that it is always and under all circumstances a reasonable use of such waters to bathe therein? Reasonable use varies with circumstances. It depends among other things upon what use is made of the water by the lower owners, whose equal rights must be respected." p.192

Case #8 *State* v. *Quattropani,* 99 Vt. 360 (1925)

Conviction and fine for boating on "boatable" waters [Constitution Chap. II §63] in violation of Board of Health ordinance against same. Waters were Berlin Pond – source of water supply for city of Montpelier. Execution ordered. While no *actual* damage was done order was reasonable because it is sufficient if it was reasonable to apprehend that boating and incidents thereof may result in contamination of the water.

Case #9 *Vermont Woolens Corporation* v. *Wackerman,* 122 Vt. 219, 167A2d533 (1960)

This is an appeal from a stream classification order which included general instructions about the level of treatment that would be expected of various categories of dischargers in order to maintain the established stream quality. The appellant was a long-time discharger of dyes and other wastes into the waters on which he was reparian and claimed that the reclassification order was unconstitutional in that he could not comply with the new stream quality with his existing treatment facilities and that building equipment such as would meet the standards was economically impossible and, therefore the order deprived him of his property without compensation. The Court declared that this appeal was premature insofar as there was no specific adjudication involving the appellant on which the Court could exercise its powers of review. Thus the Board would first have to bring a charge against Vermont Woolens Corporation or petition for Court enforcement of an order before an appeal would be timely.

Nonetheless, the Vermont Supreme Court took the opportunity presented by this appeal to express its views on the general subject and these are worth summarizing.

1. Pollution abatement carried out in furtherance of (a) public health and (b) for the protection of fish and game are appropriate areas for the exercise of the police power.

2. All contracts etc. and rights possessed and property held are subject to the proper exercise of this police power and must submit to its valid regulation and restriction.

3. Riparian rights do constitute property but they do not become by prescription invulnerable to regulation. "Without the consent of the Legislature, the interests of the State in all its waters cannot be defeated by long user, for prescription cannot be allowed to overcome public welfare."

4. "Burdensome cost is a factor to be considered in weighing the reasonableness of legislation and orders made under it when testing them for constitutionality. However, when legislation . . . is supported by strongly favored public policy considerations, [they] will not be struck down as unreasonable solely because a financial hardship is necessarily worked on a particular individual, even to the point of being destructive of his business." Citing *Anchor Hocking* v. *Barber*, 118 Vt. 206, 215, 105A261 271.

## SUMMARY OF CASE-DEVELOPED GUIDELINES

Several general guidelines emerge from an examination of these cases.[1]

1. The right to a watercourse's assimilative and transport capacity for waste disposal is a recognized property right and one of a bundle of such rights in water a riparian may possess.

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[1] No correlation between case number and numbered guidline should be inferred.

2. This use, like other uses of the water, is subject to the limitation that it must be "reasonable."

3. A waste disposal use is "reasonable" as a matter of law if it is otherwise lawful and results in no injury to downstream riparians.

4. "Reasonable use" for any legitimate riparian purpose depends upon the circumstances of stream flow, time of year, other correlative uses actually being made, but does *not* depend on any priority of time in which a use was begun.

5. A use determined to be "reasonable" at one time may subsequently become "unreasonable" due to changed circumstances such as additional users located on a river.

6. Prescriptive rights in the use of water are by and large not recognized in Vermont.

7. What constitutes a "reasonable" use is, in the last analysis, a question of fact for the trial court. In determining this fact the following types of evidence are relevant and should be considered: (1) the injury suffered by a downstream plaintiff-user caused by the discharge; (2) the expense and inconvenience to the downstream user of avoiding the pollution; (3) the expense and inconvenience to the discharger of eliminating or otherwise reducing the offending discharge. It appears from *Snow* v. *Parsons* that in "balancing" these considerations one user may have "to submit to small inconvenience to afford a disproportionate advantage to others"; and from *Canfield* v. *Andrew* that a manufacturing discharger has no right to pollute to the injury of others merely because it is "a matter of convenience and economy for him to do it."

8. In enforcing orders designed to protect the health and welfare in water pollution matters, the court will look to the practicality of enforcing the particular order at issue. Thus, if a municipal sewage treatment plant were degrading the quality of waters into which it discharged below the established standard and in violation of its temporary pollution permit, the courts might refuse to enforce a Department of Water Resources Order to cease all opera-

tions and all discharges until compliance with the temporary permit. In such a case even though the order was duly issued in all respects, a bill to enforce the order might be denied solely because the court could see no practical way to actually achieve the enforcement of such an order (people will continue to pull the chains in their water closets). An order to cease collecting customers' sewer charges until such time as compliance is had, however, could be enforced under threat of contempt of court proceedings against appropriate municipal officials and a bill for enforcement of such an order would be granted.

These considerations are rather illustrative of the day-to-day problems of enforcing a pollution control statute – even one with "teeth" in it – and highlight the need for a self-enforcing incentive mechanism such as an effluent fee system.

9. Any prescriptive rights to the disposal use of water which may have been acquired by long enjoyment are not invulnerable to change through regulation.

# APPENDIX B

## CONSTITUTIONALITY CONSIDERATIONS OF EFFLUENT CHARGE SYSTEMS

Any particular effluent charge system which we examine (or devise) and analyze for possible adoption by the Vermont Department of Water Resources must be capable of withstanding attacks of unconstitutionality by affected parties in Vermont. The relevant constitutionality criteria are outlined below in the context of Vermont law.

## I. THE CONSTITUTIONAL CRITERIA

The basis of a constitutional challenge to an effluent charge system starts from the common law proposition that riparians (and in some cases – especially in Vermont – nonriparians as well) have the right to a "reasonable" use of the state's surface watercourses. The exact delineation of these rights is highly technical but unimportant here. The key point is that "reasonable" use comprehends not only domestic, recreational, industrial and agricultural uses but also the right to reasonable use for waste assimilative and transport capacity. Such a "right" constitutes a kind of "private property" of which a discharger might be deprived by requiring him to pay first a charge before discharging waste in any amount. A discharger would then claim that the effluent charge amounted to a deprivation of private property without due process of law, without equal protection of the law and without just compensation in violation of the 5th and 14th Amendments to the U.S. Constitution.

Of course many property "rights" are subject to regulation, taxation and even "taking" by Government. The essence of the constitutional challenge is that the rights infringed were not affected in a proper way whichever power of government is relied on to justify the infringement.

### A. VALID EXERCISE OF THE POLICE POWER

An effluent charge system can be viewed – and is so viewed in Vermont – as an exercise of the state's police power wherein regulations are established for the "public good." The legal or valid exercise of such power must meet three tests: (i) there must be a proper legislative purpose; (ii) the regulations must bear a reasonable relation to that purpose; and (iii) the regulations must be neither arbitrary nor discriminatory. The standard for each of these tests is discussed in turn below.

(i) A proper legislative purpose – "Proper legislative purpose" has been defined by the U.S. Supreme Court to include protection of ". . . the safety, health, peace good order and morale of the community"[1] and the values represented may be "... spiritual as well as physical, aesthetic as well as monetary. It is within the power of the legislature to determine that the community should be beautiful as well as healthy, spacious as well as clean, well-balanced as well as carefully patrolled.[2] There is little doubt that such a broadly drawn standard could be met by nearly any particular effluent charge system likely to be considered by the Department. Section 912(e)(1) of Public Act No. 252 of 1969 sets forth the principal purpose as providing an economic incentive to reduce the volume and degrading quality of discharges and thereby raising the quality of waters in the state. Taken together with other provisions of Title 10, Chap. 33, V.S.A. the effluent charge system and the pollution control law might serve a somewhat differently articulated purpose but there is no reasonable doubt that the "proper-legislative-purpose" test would be satisfied.

(ii) Regulations bear a reasonable relation to that purpose – The standard here is that the means selected in the light of any facts known or reasonably assumed bear a real and substantial relation to the object sought to be attained.[3] Clearly many particular effluent charge systems might be debatable on this point. For example, an effluent charge system based on downstream damage costs might not provide much incentive for abatement; or a system based on treatment costs might not encourage pollution abatement to a level consistent with optimum resource allocation, if the latter were the system's purpose. However, the criteria is not the actual success of the regulation in achieving the desired objective but rather the "reasonableness" of the regulation.

Furthermore, the presumption of legislative reasonableness lies with the state and therefore any party challenging the constitutionality of an effluent charge system on this point would have the burden of establishing "unreasonableness."[4] In most cases this is a very difficult presumption to overcome and I should think most effluent charge systems would be constitutionally secure in this regard.

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[1] *Crowley v. Christensen*, 137U.S.86,89(1890).

[2] *Berman v. Parker*, 348U.S.26,32,33(1954)

[3] *Nebbia v. New York*, 291U.S.502,525(1933); *Goldblatt v. Hempstead*, 369U.S.590,596(1962).

[4] *Bibb v. Navajo Freight Lines*, 359U.S.520,529(1959).

(iii) Regulation is neither arbitrary nor discriminatory. As nearly as I can establish "not arbitrary" means nothing separate or distinct from reasonable and nondiscriminatory and therefore I proceed to a discussion of the nondiscriminatory test. Whether an effluent charge system is discriminatory is at the very heart of the due process of law and of the equal protection of law guarantees of the 5th and 14th Amendments. Necessarily an effluent charge system will establish different treatment for different classes of persons. The crux of the matter is that the classifications so occasioned must be reasonable in light of the purpose to be served and all within a class must be treated alike. By and large proper classification is primarily a legislative function and not a judicial one, but the courts do and will take a hard look at the classifications established. In this regard the precise purpose to be served by the "pollution control" system becomes very important.

Five judicially established standards for proper classification are widely accepted as operative.[1]

"(1) All classifications must be based upon substantial distinctions which make one class really different from another.

"(2) The classifications adopted must be germane to the purpose of the law.

"(3) The classification must not be based on existing circumstances only (i.e., it must not be so constituted as to preclude addition to the numbers included within a class).

"(4) To whatever class a law may apply, it must apply equally to each member thereof.

"(5) The characteristics of each class should be so far different from those of other classes as to reasonably suggest at least the propriety, having regard to the public good substantially different legislation."

A few examples may illustrate the arguments that might be advanced. Of course waste dischargers would be regulated whereas other members of the public would not. This distinction is reasonable because dischargers are actually the real cause of pollution whereas the general public is not. However, not even all waste dischargers are regulated. For example, farmers whose waste consists of run off from fields and feed-lots are not regulated; nonetheless those dischargers who are affected by the charge represent the class wherein the need for regulation is the clearest. More difficult is the distinction between those dischargers who receive a discharge permit and pay no charge and those who receive a temporary permit and must pay a charge. Here the exact basis for granting or denying discharge permits must be an integral part of the effluent charge system. One can easily hypothesize two polluters discharging equal quantities and qualities of waste into waters carrying the same minimum quality standards where the downstream damage costs are the same (however measured) but where – because of accident of location, hydrology or the presence of other users of the waters – one polluter's discharge would reduce the quality of water below the established minimum whereas the other polluters discharge would not have this same effect. Whether this classification is discriminatory is difficult to assess. The precise purpose becomes crucial. The economic incentive to reduce pollution is not the same. Moreover, similar rates are not being charged each discharger for a similar unit of waste that causes a similar amount of injury (if that be the proper test).

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[1] *State* v. *City of Milwaukee*, 33 Wis. 2d624,633; 148 N.W. 2d21, 25, 26(1967); 11 Am. Jur., Constit. Law § 128; 37 Am. Jur., Municip. Corp. § 101.

To take another example, actual assessments and rates of assessment might differ from waste discharger to waste discharger upon the same body of water in different locations, or upon different bodies of water or depending upon the time of year or other hydrological conditions. Such differences might be justified by different amounts of downstream damage caused but not by differences of incentive effect.

If effluent charges were computed upon the basis of individual waste discharger s cost of waste reduction and treatment, the system would reflect such variables as the financial status of a waste discharger's the value of his land and capital improvements, the cost and technology of his production process, and the age of his production plant. It has been suggested that such a system would be dependent on rather arbitrary considerations, would not be germane to the reduction and control of downstream damage and would be found to be discriminatory and therefore unconstitutional.[1] However, such a system might be very germane to providing an incentive for pollution abatement if that be taken to be the purpose in isolation from other considerations. Again one must query what it means for all persons "in the same class" to be treated alike. Short of knowing considerable detail about how such an effluent charge system might be devised, one can do little more than raise the questions.

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[1] Silas R. Lyman, "The Constitutionality of Effluent Charges" Univ. of Wisc. Water Resources Center, Technical Report OWRR A-022-Wis. (May, 1969p.49-52).

## B. USE OF THE STATE'S POWER OF EMINENT DOMAIN

Quite apart from the considerations outlined above regarding the validity of the exercise of the state's police power, a discharger might argue that the interference with private property interests inherent in an effluent charge system is so extensive that it constitutes a taking of private property under the state's power of eminent domain rather than an exercise of the police power. If so, the taking would be without just compensation and therefore a violation of the 5th and 14th Amendments.

The Supreme Court itself has stated that "There is no set formula to determine where regulation ends and taking begins."[1] The line seems to be drawn somewhere in the grey area between a regulation which merely deprives property of its "most beneficial use," which does *not* render it unconstitutional, and regulation which occasions a "substantial deprivation of all the rights of ownership," which does render it unconstitutional.[2]

Some state courts have said that the test depends upon whether the collective benefit derived from the regulation outweighs the specific restraint imposed by the regulation.[3] If this were the test in Vermont and an effluent charge necessary to induce behavior which meets water quality standards exceeds downstream damage costs, it is arguable that the charge exceeds the limits of regulation and constitutes an unconstitutional taking without compensation. This test has not been applied in Vermont so far and there is, at least, dictum in a fairly recent Vermont decision to the effect that in water pollution regulation the Supreme Court of that state will be most reluctant to find an unconstitutional taking:

> When supported by strongly favored policy considerations, legislation and orders will not be struck down as unreasonable solely because a financial hardship is necessarily worked on a particular individual, even to the point of being destructive of his business.[4]

The *Vermont Woolen* case is perhaps a slender reed on which to rest one's confidence since the actual holding in that case was that a constitutional appeal from a mere classification order including general instructions about pollution abatement was premature and would not be decided short of some actual adjudication involving the appellant. Nonetheless the language is helpful.

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[1] *Goldblatt* v. *Hempstead*, 396U.S.590(1962).

[2] *McKee* v. *City of Akron*, 199 N.E.2d592(1964).

[3] *Iowa Natural Resources Council* v. *VanZee* 158N.W.2d111(1968), *accord*, *Shirley* v. *New Hampshire Water Pollution Commission*. 100N.H.294,300,124 A2d189,194(1956).

[4] *Vermont Woolen Corp.* v. *Wackerman*, 122 Vt.219,228,167 A.2d533(1960), citing *Anchor Hocking* v. *Barber*, 118VT.206.

One more point with regard to the "taking vs. regulation" issue discussed here should be mentioned. There can be no question of a taking unless there is in fact some private property involved and the "right to pollute" or to the waste assimilative and transport capacity of waters may not be considered separate property but only one use a riparian may enjoy. If so, any effluent charge system would be invulnerable to constitutional challenge on this point. If there is some "right to pollute" in Vermont, it is at most only a right to "reasonable" pollution.[1] In this case "reasonable" may become synonomous with not degrading waters below the established standards and effluent fees for discharges in excess of this would be clearly permissible. However, prorationed effluent charges applicable to all dischargers – including "reasonable" users of the assimilative capacity – could conceivably constitute a "taking" sufficient to raise the issue of an unconstitutional taking without compensation. If so the discussion in the earlier part of this section would apply.

## C. THE STATE'S TAX POWER

It is possible that dischargers could claim that the imposition of the effluent charge is not really a police power regulation but in fact a tax imposed by the state; and, moreover, as a tax it is invalid because repugnant to the equal protection clause of the Federal Constitution or to State provisions for equality and uniformity in taxation. Here, in drawing the line between an exercise of the police power and of the tax power – as was the case above in distinguishing between an exercise of the police power and of the power of eminent domain – one must look to judicial construction. The general rule is that if regulation (rather than the raising of revenues) is the primary purpose of the effluent charge system then the fact that revenue is incidentally obtained does not make the imposition a tax so long as the funds are not paid into the state's treasury as general revenue.[2] It is clear that the sections of Public Act No. 252 regarding effluent charges were carefully drafted to avoid being considered a tax. The primary purpose was spelled out to be an incentive system and the revenues obtained are kept separate from the general treasury.

Another widely-followed differentiating characteristic between regulations and taxes concerns the amount of revenue collected which it is said should not exceed the necessary costs of regulation and licensing.[3] This would appear to put a considerable constraint on the level at which effluent fees might be set while retaining the status of a police power regulation. There are, however, two major exceptions to this limit on the fees that may be charged under the police power. (1) The computation of fees may be made not only on the basis of the expenses of regulation, inspection and police control, but also on the basis of "the costs of all incidental consequences that the public may suffer in consequence of the activities licensed."[1] Thus effluent charge revenues could be used to finance regional abatement measures. (2) Fees may be set high enough to effect a reasonable restriction or restraint on a practical prohibition of those businesses or activities that are deemed injurious, hurtful or dangerous to the public or businesses that the state under its police power could prohibit absolutely.[2]

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[1] *State v. Morse,* 84VT.387,392, 80A. 189.

[2] 4 T.M. Cooley, 3511, 3513(4th ed. 1924)

[3] 33 Am. Jur. *Licenses* §19 at 340; 15C.J.S. *Constit. Law* § 174 at 890; 103 A.L.R. 18 for a general listing of related state cases.

Thus, it is highly probable that any level and schedule of fees established under a Vermont effluent charge system would retain its status as a police power regulation and would not be declared a state tax. If the imposition of certain effluent charges *were* determined to constitute a tax, then the effluent charges would have to meet the equal protection requirements set forth above in the discussion on the standards for proper classification.

In addition to the Federal equal protection clause, state constitutional or statutory provisions require equality and uniformity in taxation.[3] These requirements, however, do not apply to all state taxes and usually specifically exempt excise taxes or taxes on privileges, occupation and "activities carried on amid the social economic and industrial environment under the protection of the state.[4]

## D. UNLAWFUL TAX ON A PROTECTED USE OF THE NAVIGABLE WATERS OF THE STATE

If an effluent charge is found to be a tax rather than an exercise of the police power, an additional problem is raised beyond those discussed in the last chapter – is some special use of the navigable waters otherwise protected as free by the state constitution or state enabling act, being impaired by the tax?

Under authority of the Federal Commerce Clause many state enabling acts contain provisions protecting the free use of navigable waters as common highways. Presumably such protection extends to interstate and international commerce and transportation and not to other uses of the waters. Some state constitutions protect other uses such as for fishing in Vermont and various public beneficial uses for recreation as in Wisconsin. Presumably waste disposal is not included in these protected uses as incidents to them. If so, however, the tax might still be valid under the exception for tolls placed as compensation for the use of state constructed improvements on a navigable waterway or under the exception for incidents of navigation that may be interferred with by the legislature when sound public policy demands it.

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[1] 4 Cooley, *Taxation*, § 1809 at 3552(4th ed. 1924) *Ewell* v. *Board of Supervisors*, 234 La. 419, 100So. 2d 221(1958).

[2] *United States* v. *Sanchez* 340 U.S. 42(1950); *Tanner* v. *Little*, 240 U.S. 369(1915.

[3] W.J. Newhouse, *Constitutional Uniformity and Equality in State Taxation* (1959) for a listing and discussion of each state's equal and uniform clause.

[4] *Ballentine's Law Dictionary*, word defined at 1018.

Thus if an effluent charge were determined to be a tax, one would argue either that it was a toll for state improvements or a valid excise tax upon the privilege of disposing waste into the state's waters.

## E. CONSTITUTIONAL ISSUES OF ONLY MARGINAL INTEREST TO THE DESIGN OF AN EFFLUENT CHARGE SYSTEM

There are a number of constitutional issues which need not concern our evaluation of effluent charge systems but which are sketched here for completeness.

### 1. Unlawful Delegation

A party objecting to the establishment of an effluent charge system scheme might always claim that placing the administrative and design responsibility for an effluent charge system into the hands of a public agency amounts to an excessive and therefore unlawful delegation of both legislative and judicial power. The tests usually applied to determine the proper limits on the delegation of legislative power are: (i) the statute must delineate the policy to be served; (ii) the statute must designate the public agency to administer it; and (iii) the boundaries of the delegated authority must be delineated by general standards or guidelines, but specific formulas need not be given where variable conditions constitute the essence of the program.

The test applied to the proper delegation of judicial powers is that the judicial powers actually delegated must be incidental to the agency's function, but in any event may not include the power to decide legal rights between private parties.

### 2. Denial of Downstream User's Rights to Recover Damages and to Enjoin Injurious Activities in Violation of Due Process

Corresponding to dischargers' alleged "right" to reasonable use of waters for waste disposal is downstream users' right to the use of water of reasonable quantity and quality. Thus a downstream riparian could claim that a permit and effluent charge system which allowed upstream users to unreasonably degrade the quality of water he receives would deny him his right to damages and to enjoin such injurious activity – constituting a deprivation of property without just compensation and in violation of the due process and equal protection clauses.

Section 919 of Vermont Public Act No. 252 of 1969 carefully preserves these rights to compensatory and injunctive relief. Thus the Water Resources

Board does not have primary and exclusive jurisdiction which might cut off existing common law remedies. These remedies continue in force alongside the discharge and pollution permit requirements. If a court were to grant an injunction in a private nuisance suit against a permit holder, the implication would clearly be that the Department of Water Resources and/or the Water Resources Board had exceeded its limits of authority to establish effluent charges and grant permits. Similar limits on the effluent charge system are already placed in other jurisdictions by statutes which may prohibit the discharge of raw sewage or the discharge of such quantity and quality of waste as to materially reduce the receiving body's quality below the minimum standard. In Vermont, it seems, that a downstream user is still protected against a judicially determined "unreasonable" waste-disposal use of the waters even by a valid temporary pollution permit holder. It remains, of course, to be seen to what extent the Vermont Courts will in practice defer to the judgment of the Department and the Board.

### 3. A State's Navigational Servitude

Even if an effluent charge failed to pass a constitutional challenge as a valid exercise of police power or as a lawful tax measure, the State might rely on its navigational servitude over the state's waters and argue that the effluent charge is designed to protect and aid navigation and that all riparian rights are subject to this servitude. Such a defense would probably not be valid in Vermont because the legislation does not state that the effluent charge system is supposed to be in aid of navigation.

### 4. The Public Trust Doctrine

Aside from the various powers already discussed under which the state might impose an effluent charge, it has been asserted that the general public has an interest in the navigable waters of the state that is superior to any right of any individual so that when acting for the general public, statutory regulations may be enacted without incurring liability for compensation for private rights affected.[1] This same notion is sometimes expressed by the idea that "the state holds the navigable waters in trust for the people.[2] The essence of the trust doctrine is to assure that the regulation of riparian rights for the public benefit and without compensation is clearly an exercise of the police power for a proper legislative purpose and valid (provided the requirements of reasonableness and equal protection in setting classifications are met) and therefore does not result in a taking of private property for which compensation need be paid under the 14th Amendment.

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[1] *U.S. v. Hudson Water Co. (Hudson Water Co. v. McCarter)*, 209 U.S. 349 (1908) Colberg v. State, 62 Cal., 401, 432 P2d 3 (1967).

[2] Trelease, *Governmental Ownership and Trusteeship of Water*, 45 Cal. L. Rev. 638, (1957).

## APPENDIX C

# SOME THOUGHTS ON THE ECONOMICS OF POLLUTION FEES RELATED TO THE VERMONT SITUATION

Economists point out that the efficient allocation of a scarce resource requires its use by those who will derive the most utility from it, and that a free competitive market will achieve this result. In a free market, each individual has the opportunity to buy any resource for the price he is willing to pay. If a second party is willing to pay more, then that resource is worth more to him and will be put to a higher use by him. The conditions which must exist for the efficient allocation of resources through the market process are extensive. Only those which bear directly on the optimal allocation of the waste assimilative and transport capacity of watercourses are considered here.

Presently, the waste assimilative and transport capacity of the water resource is essentially a free good. Dischargers may use it without payment to any party or individual. To be sure, dischargers may be administratively prohibited from the use of some part or all of the resource. Such is the case where effluent standards are the basic allocational mechanism. Also administrative restriction on use has come from litigation through the courts.

A free good is one for which the marginal value is zero. The marginal value of the open sea for transportation is zero, for example, since another ship can move over a bit; no one is willing to pay for more open sea. However, the use of streams and lakes for waste disposal is not a free good if this use precludes or reduces the value of the water for some other use. If waste disposal requires additional expenditure for purification, then there is an opportunity cost to use for waste disposal. Currently, there is no market mechanism to reflect that opportunity cost. The closest we come is in recourse to the courts for damages to other users.

An efficient allocation of water resources might be achieved by establishing a free market for them – for drinking, swimming, boating, fishing, and waste disposal. In such a market, each potential user could bid to use the stream. For example, if the stream were of more utility for waste disposal than for swimming, then dischargers of wastes would pay the swimmers for the lost opportunity of swimming. Conceivably, dischargers of wastes might buy out all clean water users in order to use the water for waste disposal, but in the perfect market, the price established would compensate for all damage, including psychic loss. This example assumes that the property right belongs to clean water users to sell.

However, it is possible to develop the same efficient allocation of resources by assuming property rights rest with waste dischargers. In that case, users of clean water would bid for their use of the water by paying the waste dischargers who could then use the money to dispose of wastes in some other manner.

It has been contended that these two approaches are symmetrical and that the only difference between the two is in the redistribution of income. Symmetry rests on the assumption that the discharger cannot alter (in the short or long run) the mix between final and waste products. In fact, this mix can be varied, and if payment is received for wastes produced (even if only to clean them up) there is an incentive to maximize waste products, although there will be a limit on the amount which can be collected from the users of clean water. If the discharger charges enough, swimmers may build their own pools, drinking water can be trucked in, sport fishermen could engage in other sports. The logical extreme of the vesting of the property right completely with the discharger is the plant which threatens to dump nitric acid into the river for no other purpose than to collect a payment for not doing so. There is some amount which clean water users will pay to keep the acid out. It would be a very profitable operation, since the entrepreneur would be paid for not using the acid; thus, the only capital required would be a pipe and a shack with sufficient acid to make his threat credible.

The above is an extreme of a system of property rights. The courts have given property rights to dischargers but these have been limited by the doctrine of what is reasonable. Society has so far decided that no one has an absolute property right to the water resource. A middle ground – that the state has the right to the water resource – has been suggested. The pure economic solution, then, is for all potential users to bid to the state for the right to use the water for waste disposal, swimming, fishing, whatever. There would be bidding among all users. Money received by the state could be used for anything – highways, parks, swimming pools, or water pollution control facilities – whatever results in the greatest return.

In the light of the above, if the state must spend money for pollution abatement or in payments to damaged parties, then it simply becomes a transfer agent between property owner and purchaser. If dischargers bid successfully for the right to use the water for waste disposal, the state has two options. It may build a treatment facility or pay the damaged parties. Bidding would establish that clean water users had the property right to the water which was sold by the state for them to waste dischargers. If the clean water users successfully bid, the state may use their money to clean up the dischargers' effluents, or subsidize the discharger to do so himself. Thus, the discharger had the original right to the water, since the right to it was bought from him. If the state must spend the revenue on pollution abatement (and/or damage payments), the party which gets the benefit of the fee is established as the party which had the original right to the water.

A fee system based on downstream damages assumes that downstream clean water users have the basic property right to use of the stream. The function of the state is to provide a quasi-market in a situation where no market exists. The economist argues that the state functions to convert an external diseconomy into an internal market calculation. A fee system based on downstream damages can have three results, all equally satisfactory from the point of economic efficiency. One, the amount required by the discharger to treat his wastes will be less than amount of the fee, so the discharger will treat. Two, the state may decide that it can clean up the wastes in the stream by any number of means which might not be available to the individual firm. Third, the state can pay those damaged for their loss.

The problem in the above system is the valuation of damages suffered by downstream users. In open-market bidding for stream use, the value will be set at the total value to clean water users. However, bidding is for a strange product. Some uses of clean water can vary by quantity used; others are dependent on the quality. Drinkers of water will demand a certain quality. Demand and supply will vary with price in the classic manner. Thus, use is exclusive; that is, the use by one person excludes the possibility of its use by another. However, other uses of clean water are nonconsumptive. A swimmer or boater does not significantly alter the product. If there is one swimmer, there is still room for another. The first may be willing to pay a large amount, the second a much smaller amount. The owner of the resource has the option of selling the resource many times at different prices to different users.

With a product which is consumed, total revenue generated will be the single price times the quantity, the area bounded by ABCE, in Figure I, the classic demand curve analysis.

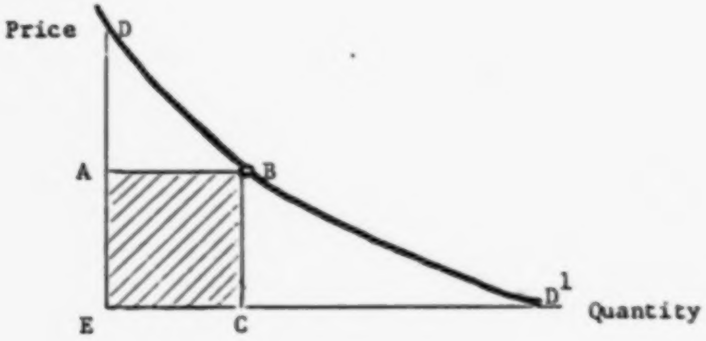

Figure I

If the product can be sold several times without being used up, it is possible to derive revenue from the total area under the demand curve EDD$^1$ (Figure II).

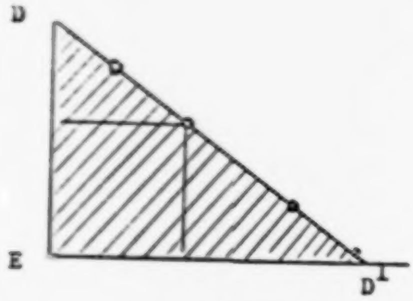

**Figure II**

The skillful seller of the resource could charge each individual a separate price equal to the total utility to that individual. However, he would probably only get away with it once. When people learn that he is willing to sell for less than they paid, they will reduce the amount they will pay. The normal functioning of the market would reduce the price to just above zero very quickly because the marginal cost would be zero to provide for additional users.

Bidding can be conceived of as taking place for various levels of water quality. If quality is low, the demand curve will simply shift down. Individuals who would pay a little for pure water won't pay anything for dirtier water; individuals who would pay more will pay less. Still the marginal cost to provide for an additional user of the good water of a given purity is zero. Thus, the commodity which we attempt to value is such that the market mechanism, working freely with owners attempting to maximize revenues will not necessarily produce any return to them. The problem is that the product, once established, has zero marginal cost. Thus, the state must do more than simply function as a market; it must determine individual preferences which would not be revealed in a market situation.

The state can assign downstream damages in several ways. They can be taken as the cost of correcting the condition by means other than treating effluent. This approach is basically to determine the cost of providing clean water or alternative services some other way. Thus, the cost to produce drinking water would be the cost of purifying the polluted stream intake or of transporting clean water. Recreation damage could be calculated through the costs required to produce an alternate water-oriented recreation opportunity, such as an artificial lake. Damages so derived may be more or less than the actual consumer value placed on the availability of clean water in natural streams or lakes.

The state can also attempt to value the recreational experience in terms of dollars per swimmer-day, boater-day, etc. Then, the number of these activity-days foregone per unit of production must be estimated. There are problems in determining the value of each day and the slope of the demand curve per unit of pollution. A good deal has been written on the valuation of the recreation experience but none is satisfactory for operationally deriving that value.

The state can also decide politically that certain water quality conditions are to be maintained. These standards become proxies for downstream damages along each specific reach of stream and lake. Standards say that the activity permitted is worth more than the cost of cleaning up the stream to meet those standards. They also say that the marginal value of the additional activities permitted by slightly cleaner water are worth less than the cost of bringing the water to that higher quality. The setting of standards is a political process but much of the process of setting downstream damages is also political and perhaps it is most appropriate to be direct. Once standards are established, it is possible to translate them into appropriate concentrations of pollutants, from which it is possible to calculate the total waste capacity of the stream reach or lake. This capacity is the amount of waste in physical terms which can be assimilated and/or transported, consistent with the desired downstream activities.

The problem is: who gets the capacity to assimilate or transport waste? The optimal solution is for the State to sell the right to use the waste capacity. By so doing, it will be used by the individual discharger to whom it is worth the most. The product is limited, and if one party is using all of it, there is no more capacity for others. The supply is fixed – i.e., the supply curve is vertical, no change of price will result in any more or less being supplied. The demand curve will be determined by costs evolved with disposing of wastes by some means other than the river. The establishment whose wastes are cheapest to treat or dispose of by some other means will be the first to turn to nonriver means. It is possible, and likely, that no discharger will completely clean up his wastes but will clean up to the point where the marginal cost of cleaning up the next unit is greater than the market price for a unit of stream discharge capacity.

Sale of waste capacity can be extended to many types of pollutants – BOD, dissolved solids, etc. One establishment may bid only for BOD capacity, another may bid for all. The market would provide an efficient allocation of capacity among those seeking to use it.

If there is insufficient activity along the river to generate enough waste to bring the river below standard, then the price bid will be zero since there is over-supply. This is because the supply curve for waste carrying capacity is based on standards which are step functions.

The bidding system would be fine if, historically we had started out with it before any waste-generating activity came on the scene. However, the problem is complicated by the fact that the establishments which can't buy the waste capacity of the stream cannot stop using it immediately. A transition must be made. Establishments which opt for other means of waste disposal need time to put those means into effect. If every discharger had no treatment facilities, an equitable solution in the transition period would be to sell the capacity starting in some period in the future to provide time to adjust production or install treatment facilities. In actuality, some establishments have operational treatment facilities. Those who have delayed should not benefit over treaters. Thus, in transition, there needs to be some sort of tax or fine to prevent an undesired redistribution of income from individuals currently treating to those not treating.

A fine can be assessed in a number of ways. Establishments will know how much it will cost them to treat, so distribution could be adjusted by charging a fee based on their individual cost of treatment. Each could be charged the market price, which will be greater than their cost of treatment and will represent a punitive fine; each could be charged a fee based on the damages caused by the pollution levels greater than permitted by standards; or there could be a simple flat punitive fine.

It would appear that under the present Vermont law, the option of open bidding for discharge permits is not available. The Department must decide which discharges qualify as not lowering the quality below the standard. Without bidding, an efficient result can be arrived at by constructing cost-of-treatment functions for all establishments and deriving the individual discharges which would result from the linear programming solution constrained to least cost. In fact, this would be a restatement of the classic diet problem.

Another manner for distributing the usable stream capacity would be to apportion it among existing dischargers on the basis of their present production of pretreatment wastes. Thus, if each establishment produces waste discharge (Di) and the waste capacity of the water is C, then C would be distributed to each individual establishment by the ratio:

$$\frac{D_i}{\sum_{i=1}^{n} D_i}$$

or each establishment's usable capacity (Ui)would be

$$C \frac{D_i}{\sum_{i=1}^{n} D_i}$$

This solution might be allocating waste capacity to establishments whose marginal cost of waste treatment is less than somebody else's. If so, the solution is not Pareto Optimal since the party whose marginal treatment cost is higher would be willing to buy some capacity from the party whose marginal cost is lower, and the party whose marginal cost is lower would be willing to sell.

Other means of distributing the waste-carrying capacity would be to give it to upstream users first or to the users who arrived first historically. It is reasonable to expect that either of these schemes would not stand up in court, neither of them are economically efficient, and it is hard to see merit in them other than attempting to define the marginal user.

Whatever administrative means is used to allocate waste-carrying capacity of the stream, there is still the problem of moving through the transition period to the point that wastes over and above waste-carrying capacity are treated. The options are the same as described briefly above. Since it is the period of transition which is the crux of the matter in Vermont, we must now deal with the issue more fully.

The one thing which is not at issue in the transition period is the allocation of resources. This problem is solved in the distribution of the waste-carrying capacity to the individual establishments. The one central economic effect of the fee is to prevent a redistribution of income from existing treaters to polluters. This redistribution would occur without the fee because existing treaters will bear the cost of treatment (annualized capital and operating costs) during the period of transition, while establishments building plants will bear lower costs due to smaller capital investment and no operating costs.

The fee could be used to duplicate the post-transition costs for each establishment, based on annualized cost of treatment for each less annualized costs of facilities in place or partially constructed. The establishments would already be paying annualized costs on the portion of facilities installed, thus the fee should be based on the unconstructed remainder plus operating costs. If the fee is greater than that, there will be a redistribution from polluters to existing treaters since the polluters costs will be higher than if they had treatment facilities already operating. It would be possible to prorate the fee on some simple proportion of the closeness to completion of the facility under construction. If the means of reducing pollution loadings is internal plant housecleaning, then the fee should be based on the costs of necessary alterations.

The above fee system would make the individual establishment's costs equal during the transition period and after. Since the costs would be equal, there would be no economic incentive to put remedies into effect; the establishment would be ambivalent and see no advantage in getting its pollution control scheme into operation before the deadline established by the State. For the fee to provide an incentive effect, it must be higher than the "equalizing" fee, so as to produce an incentive to have pollution control schemes operating quickly. (Only if the fee were arbitrarily continued to the end of the transition period, even if an establishment put its treatment facility into operation before the end of the period, would there be an incentive to delay.)

The dischargers are not the only parties who are affected in terms of incoming redistribution during the transition period. In the period after transition, downstream water users will not have to suffer the damages of pollution. Thus, there could be a fee based on downstream damages which could be paid to the sufferers of the damage. This would permit the total distribution picture of society to shift immediately to the post transition state, except to the extent that the fee on polluters is greater than their ultimate cost of treatment.

There are great difficulties in determining damages and particularly in determining the damaged individuals. The damaged individuals will be those who are not using the water. If the state advertised that it is going to pay damaged individuals, they may come from many miles around.

# APPENDIX D

# APPLICATION FORM, SCHEDULES AND GENERAL INSTRUCTIONS

Serial No.____________
Schedule No.__________
Date:________________

## STATE OF VERMONT
## DEPARTMENT OF WATER RESOURCES

## APPLICATION FOR PERMIT TO DISCHARGE WASTES INTO THE WATERS OF THE STATE AFTER JULY 1, 1971

**Instruction**: Submit a single copy of this application and appropriate schedule(s) together with application fee payment to the Department of Water Resources, State Office Building, Montpelier, Vermont. See detailed instructions attached. Do not write in boxes. Please type or print clearly.

1. Name________________________________________
2. Mailing address__________________________________
3. Telephone number________________ Date submitted______________
4 Legal person of applicant (see instructions) ________________________

____________________________________________

The above named person hereby applies for a permit to discharge wastes, directly or indirectly, into the waters of the State of Vermont on or after July 1, 1971, as described in this application and its attached schedules.

5. Name of activity (e.g., municipality, plant, individual dwelling) from which discharge will occur:

____________________________________________

6. Location of activity: Town____________ County____________________

7. Enter below, on separate lines, a brief description of each independent discharge which will result from the activity described in item 5.

(1)__________________________________________
(2)__________________________________________
(3)__________________________________________
(4)__________________________________________
(5)__________________________________________
(6)__________________________________________

**Serial No.** ____________
**Schedule No.** ________
**Date:** ______________

## STATE OF VERMONT
## DEPARTMENT OF WATER RESOURCES

For each of the discharges entered in item 7, attach a separate schedule describing the discharge. See instructions for type of schedule applicable for each discharge. **IMPORTANT**: Each independent discharge will be considered separately for permit eligibility and separate permits will be required for each discharge.

8. Name of Authorized Representative

| | | |
|---|---|---|
| (type or print) | (title) | (signature) |

**NOTE**: The department may revoke any permit issued by its pursuant to this application if it finds that the permit holder submitted false or inaccurate information in his application (10 VSA, § 913a).

**Serial No.** ________
**Schedule No.** ______
**Date:** __________

## STATE OF VERMONT
## DEPARTMENT OF WATER RESOURCES

Application for Permit to Discharge Wastes
SCHEDULE A – Municipal Discharges, page A-1

PART I

A-1 Name: ________________________________________

A-2 Enter number and name of discharge to which this schedule applies as listed in line Item 7 of application form:

________________________________________

A-3 Description of corporate or other boundaries to which this schedule applies:

________________________________________

A-4 Estimated total population within above boundaries (as of July 1, 1971):

________________________________________

A-5 Approximate percentage of above population to be served by discharge system reported in this schedule:

________________________________________

A-6 If answer to A-5 above is less than 100%, indicate disposition of wastes from remaining population:

________________________________________

A-7 Will waste discharge for which this schedule applies include other than domestic components? ____Yes ____No

A-8 If yes, indicate approximate percent breakdown:

Residential ________Commercial _______Industrial _____Other _____

A-9 List name and type of activity of all users of the system (if any) whose individual volume of discharge is expected to be greater than 5% of the total system volume, or whose waste in any amount will significantly affect the composition of the total waste load:

(1) ________________________________________
(2) ________________________________________
(3) ________________________________________

(attach extra sheet if needed)

Serial No. ________
Schedule No. ______
Date ____________

## STATE OF VERMONT
## DEPARTMENT OF WATER RESOURCES

Application for Permit to Discharge Wastes
SCHEDULE A – Municipal Discharges, page A-2

A-10 Indicate type of system which will be used to collect the wastes reported in this schedule:

(1) Separate sanitary sewer ______________________________

(2) Combined sanitary-storm sewers ______________________________

(3) Other (describe) ______________________________

______________________________

A-11 What will be the approximate daily volume of wastes collected by the system (gallons per day) ______________________________

(If unknown, so state. Do not include storm water discharge.)

A-12 What general type of treatment will the wastes receive as of and after July 1, 1971:

(1) None ____________ (2) Primary ____________ (3) Secondary ______
(4) Other (describe) ______________________________

A-13 Will treatment include chlorination prior to discharge? ___Yes ___No

A-14 Have engineering reports describing the above treatment facility been filed with the Department of Water Resources? (This applies only to such treatment facilities as presently exist and/or can be expected to be in operation as of July 1, 1971.) ___Yes ___No

If yes, enter date of filing ______________________________

If no, but reports are available, attach a copy of such reports. See instructions for necessary information to be included with the reports.

A-15 Will treatment facilities expected to be in operation on July 1, 1971 be operated and maintained on a 24-hour basis, 365 days per year (except for unforeseeable events)? ___Yes ___No

If not, indicate periods of less than full-time operation ______________________________

______________________________

A-16 Enter information about person(s) who will be responsible for the operation and maintenance of the treatment facility:

(a) Name(s) ______________________________

(b) Certified as treatment plant operator(s)? ___Yes ___No

A-17 Point at which discharge will enter waters of state:

(1) Name of stream or lake (from USGS sheet, or if unnamed, indicate nearest named stream) ______________________________

(2) Indicate distance or other specific reference from fixed landmark

______________________________

Serial No. ________
Schedule No. ________
Date: ________

## STATE OF VERMONT
## DEPARTMENT OF WATER RESOURCES

Application for Permit to Discharge Wastes
SCHEDULE A – Municipal Discharges, page A-3

(for Department use only)

Minor Basin: ________ Sub-basin: ________
3rd Level Basin: ________ 4th Level Basin: ________ 5th Level Basin: ________
USGS Sheet Name: ________ Lat. ________ Long. ________
Classification: ________ Intrastate ________ Interstate ________
Drainage Area (sq. mi.): ________ River Mile: ________
Stream Gage Reference: ________ Average Annual Flow (cfs) ________
Low Flow: ________ Basis: ________

Department action with respect to application for discharge permit (10 VSA, Section 911a).
Additional Information: ________
Action: (granted ____) (denied ______)
Notification: by: ________ date: ________

**PART II**

The remaining part of this schedule applies only to applications for *temporary pollution permits.* Dollar values *must* be included as a basis for pollution charge calculations.

A-18 Have actions been taken which could lead to new or modified treatment facilities which would become operational after July 1, 1971? ___Yes ___No

A-19 Actions completed to date regarding future waste treatment:
(1) Type of facility (check one): New Plant ___ Modifications ___
(2) Preliminary engineering report:
a. Date received ________
b. Date approved by Department of Water Resources ________
c. Cost of engineering report:
Funded by Applicant $ ________ by grants $ ________
d. Estimated project costs:
Total cost, collection system $ ________
Total cost, treatment system $ ________
Annual cost, maint. & oper. $ ________

Serial No. ____________
Schedule No. ________
Date: ______________

# STATE OF VERMONT
# DEPARTMENT OF WATER RESOURCES

Application for Permit to Discharge Wastes
SCHEDULE A – Municipal Discharges, page A-4

(3) Final engineering report:

- a. Date received ________________
- b. Date approved by Department of Water Resources ________________
- c. Cost of engineering report:
  - Funded by Applicant $ __________ by grants $ ______________
- d. Estimated project costs:
  - Total cost, collection system $ __________
  - Total cost, treatment system $ __________
  - Annual cost, maint. & oper. $ __________

(4) Capital funding approved to date and available for use (local contributions only; do not include any State or Federal grants):

- a. Amount attributed to municipality $ __________
- b. Amount attributed to industrial users of joint system $ __________
- c. How funded (check one): Appropriated __________ Bond Issue ______
  - Bond Maturity (years) __________ (Interest Rate) ______________

(5) Expenditures to date:

- a. Professional services (legal, financial, or engineering not reported above) $ __________
- b. Land and easements $ __________
- c. Damages and relocations $ __________
- d. Debt interest $ __________
- e. Construction $ __________
- f. Other ______________________ $ __________

Department action with respect to application for temporary pollution permit (10 VSA. § 912a).

Additional Information ______________________________________

Action: (granted ________ ) (denied __________ )

Notification by: ____________________________ date: ______________

Serial No. ________
Schedule No. ________
Date: ________

## STATE OF VERMONT
## DEPARTMENT OF WATER RESOURCES

Application for Permit to Discharge Wastes
SCHEDULE B – Industrial and Institutional Discharges, page B-1

### PART I

B-1 Name: ________________________________________

B-2 Enter number and name of discharge to which this schedule applies as listed in line Item 7 of application form:

________________________________________

B-3 Indicate the type of activity or activities which will generate the wastes relating to this schedule. Check appropriate entries below, or describe in space provided. See also general information sheet.

( 1) Meat processing; packing ________
( 2) Dairy products; fluid milk ________
( 3) Dairy products; butter, cheese ________
( 4) Paper and pulp manufacture ________
( 5) Lumber and woodworking activities ________
( 6) Textile manufacturing ________
( 7) Cut stone and stone products ________
( 8) Stone quarrying ________
( 9) Sand and gravel processing ________
(10) Machine tool operations ________
(11) Chemical manufacturing ________
(12) Motels ________
(13) Resorts ________
(14) Public Institutions ________
(15) Other (describe) ____________________ ________

B-4 Describe the flow sequence for the system applicable to this schedule, including treatment facilities, if any, which will be in operation on July 1, 1971. Attach any applicable plans or drawings. See general information sheet for further instructions. Attach extra pages if needed.

________________________________________
________________________________________
________________________________________
________________________________________
________________________________________
________________________________________

Serial No. __________
Schedule No. __________
Date: __________

## STATE OF VERMONT
## DEPARTMENT OF WATER RESOURCES

Application for Permit to Discharge Wastes
SCHEDULE B – Industrial and Institutional Discharges, page B-2

B-5 Indicate the maximum volume and frequency of wastes which will occur after treatment (if any), and which will enter the waters of the State. Use either Option A or Option B below:

Option A: You may use this option only if the nature of the waste discharge is limited to sanitary sewage wastes from resorts, motels, or institutions.

(1) Average number of persons served per day __________

(2) If operating on a seasonal basis, from __________ to __________

Option B: Complete Tables B-1 and B-2 below.

Table B-1

Enter maximum *volumes* of water in gallons to be discharged during indicated periods. If essentially the same for all months, check here ____ and complete first line only.

|  | Weekdays |  |  | Weekends |  |  |
|---|---|---|---|---|---|---|
| Month | Day | Evening | Night | Day | Evening | Night |
| Jan |  |  |  |  |  |  |
| Feb |  |  |  |  |  |  |
| Mar |  |  |  |  |  |  |
| Apr |  |  |  |  |  |  |
| May |  |  |  |  |  |  |
| June |  |  |  |  |  |  |
| July |  |  |  |  |  |  |
| Aug |  |  |  |  |  |  |
| Sept |  |  |  |  |  |  |
| Oct |  |  |  |  |  |  |
| Nov |  |  |  |  |  |  |
| Dec |  |  |  |  |  |  |

Comments relative to Table B-1 (if any):

Serial No. ________
Schedule No. ______
Date: ________

## STATE OF VERMONT
## DEPARTMENT OF WATER RESOURCES

Application for Permit to Discharge Wastes
SCHEDULE B – Industrial and Institutional Discharges, page B-3

B-6

### Table B-2

State the *maximum concentrations* of pollutants as itemized below which will be contained in the wastes discharged into the waters of the State (i.e., after treatment, if any). Complete all lines – if no pollutant of the type described is added, enter "none added"; if the pollutant is present but the amount is unknown or uncertain, enter "present" and describe the circumstances relating to its presence, including amounts. Use separate sheets as necessary.

BOD (5 day) ____________________ mg/l
COD ____________________ mg/l
Suspended solids ____________________ mg/l
Settleable or floating solids ____________________ mg/l
Oil or grease ____________________ mg/l
Color ____________________ (yes or no)
Turbidity ____________________ mg/l
Materials affecting taste or odor ____________________ (yes or no)

pH range (low to high) ____________ to ____________
Temperature of discharge water ____________ °F
Temperature of stream after discharge ____________ °F
Total dissolved solids ____________________ mg/l
Chemicals: (itemize)
____________________ mg/l
____________________
Chlorine (residual after treatment) ____________ mg/l

Serial No. ________
Schedule No. ________
Date: ________

## STATE OF VERMONT
## DEPARTMENT OF WATER RESOURCES

Application for Permit to Discharge Wastes
SCHEDULE B – Industrial and Institutional Discharges, page B-4

B-7 Will treatment facilities expected to be in operation on July 1, 1971, be operated and maintained at all times that waste discharges occur? ____Yes ____No

If not, indicate periods of less than full-time operation ________________

________________________________

B-8 Enter information about person(s) who will be responsible for the operation and maintenance of the treatment facility:

(a) Name(s) ________________________________

(b) Certified as treatment plant operator(s)? ____Yes ____No

B-9 Point at which discharge will enter waters of State:

(1) Name of stream or lake (from USGS sheet, or if unnamed, indicate nearest named stream)

________________________________

(2) Indicate distance or other specific reference from fixed landmark.

________________________________

(for Department use only)

Minor Basin: ________________ Sub-basin: ________________
3rd Level Basin: ____________ 4th Level Basin: __________ 5th Level Basin: ______
USGS Sheet Name: ________________ Lat. ____________ Long. ____________
Classification: ________________ Intrastate ________ Interstate ____________
Drainage Area (sq. mi.): ________________ River Mile: ____________
Stream Gage Reference: ____________ Average Annual Flow (cfs) ____________
Low Flow: ________________ Basis: ________________

Serial No. __________
Schedule No. ________
Date: _____________

## STATE OF VERMONT
## DEPARTMENT OF WATER RESOURCES

Application for Permit to Discharge Wastes
SCHEDULE B – Industrial and Institutional Discharges, page B-5

Department action with respect to application for discharge permit (10 VSA. Section 911a).
Additional Information: ________________________________________
Action: (granted ____ ) (denied ____ )
Notification: by: __________________________ date: _________________

### PART II

The remaining part of this schedule applies only to applications for *temporary pollution permits.* Dollar values *must* be included as a basis for pollution charge calculation.

B-10 Have any steps been taken which could lead to the installation of new treatment facilities and/or modifications to existing facilities, and which would become operational after July 1, 1971? ____Yes ____No

B-11 If yes, indicate the expected status of such actions as of July 1, 1971 by completing the following as applicable:

| Action | Date Started | Date Completed or Target |
|---|---|---|
| Research on methods | | |
| Preliminary engineering plans | | |
| Final engineering plans | | |
| Construction | | |
| Start-up operations | | |
| Others | | |

(1) Have any plans for the above proposed facilities been submitted to the Department of Water Resources for approval? ____Yes ____No

If yes, indicate date ____________________________________

(2) If action is limited to methods of treatment, describe treatment.

_________________________________________________

_________________________________________________

**Serial No.** ________
**Schedule No.** ________
**Date:** ________

## STATE OF VERMONT
## DEPARTMENT OF WATER RESOURCES

Application for Permit to Discharge Wastes
SCHEDULE B – Industrial and Institutional Discharges, page B-6

B-12 Have any steps been taken which may result in the wastesherein described being discharged into a municipal system after July 1,1971? ____Yes ____No
If yes, give details ________________________________________

________________________________________

B-13 Indicate below the total capital and annual operating costs for the existing (as of July 1, 1971) waste treatment facility (if any) and the additional capital and operating costs for the proposed facilities.

(1) Cost for facilities operating as of July 1, 1971:

| | |
|---|---|
| a. Total capital cost | $ ________ |
| b. Average annual equipment replacements | $ ________ |
| c. Average annual cost for supplies | $ ________ |
| d. Average annual cost for labor | $ ________ |
| TOTAL | $ ________ |

(2) Cost for proposed facilities:

| | |
|---|---|
| a. Total capital cost | $ ________ |
| b. Average annual equipment replacements | $ ________ |
| c. Average annual cost for supplies | $ ________ |
| d. Average annual cost for labor | $ ________ |
| TOTAL | $ ________ |

Department action with respect to application for temporarypollution permit (10 VSA § 912a).
Additional information ________________________________________
Action: (granted ____) (denied ________)
Notification: by: ____________________ date: ____________________

Serial No. ________
Schedule No. ______
Date: ___________

## STATE OF VERMONT
## DEPARTMENT OF WATER RESOURCES

Application for Permit to Discharge Wastes
SCHEDULE C – Domestic and Commercial Discharges, page C-1

**NOTE:** Use this schedule only if the waste is domestic in origin, consists of a single discharge, and does not exceed 1000 gallons per day.

### PART I

C-1 Name: ________________________________________

C-2 Enter sequence number and name of discharge to which this schedule applies as listed in line Item 7 of application form:

________________________________________

C-3 Number of persons served: ________________________________________

C-4 Year-around use (check) ______ or period of use ____________________

C-5 Indicate type of waste treatment to be in use on and after July 1, 1971:

(1) No treatment (direct discharge) ____________________
(2) Cesspool with overflow ____________________
(3) Septic tank with overflow ____________________
(4) Other (describe) ____________________

C-6 Approximately what percent of the raw waste volume (before treatment, if any) discharges to surface waters (after treatment, if any): ____________

C-7 Point at which discharge will enter waters of state:

(1) Name of stream or lake; if unnamed, indicate nearest named stream:

________________________________________

(2) Indicate distance from or other specific reference to fixed landmark:

________________________________________

**Serial No.** ______
**Schedule No.** ______
**Date:** ______

## STATE OF VERMONT
## DEPARTMENT OF WATER RESOURCES

Application for Permit to Discharge Wastes
SCHEDULE C – Domestic and Commercial Discharges, page C-2

(for Department use only)

Minor Basin: ______ Sub-basin: ______
3rd Level Basin: ______ 4th Level Basin: ______ 5th Level Basin: ______
USGS Sheet Name: ______ Lat. ______ Long. ______
Classification: ______ Intrastate ______ Interstate ______
Drainage Area (sq. mi.): ______ River Mile: ______
Stream Gage Reference: ______ Average Annual Flow (cfs) ______
Low Flow: ______ Basis: ______

Department action with respect to application for discharge permit (10 VSA, §Section 911a).
Additional information: ______
Action: (granted ______) (denied ______)
Notification: by: ______ date: ______

**PART II**

The remaining part of this schedule applies only to applications for *temporary pollution permits*. See instructions before completing.

C-8 Have any actions been taken which would lead to the installation of new or modified treatment facilities to treat the reported discharge alone (i.e., not a tie-in to a sewage collection system), and which would become operational after July 1, 1971? ___Yes ___No If yes, explain and give size of facility (i.e., gallon capacity of septic tank, size of leaching field, etc.)

______

______

C-9 Have any actions been taken which could lead to the collection of the waste discharge reported herein in a sewage collection system, whether operated by a municipal or a private corporation, and which would become operational after July 1, 1971? Yes No If yes, explain and give name of corporation.

Department action with respect to application for temporary pollution permit (10 VSA. § 912a).
Additional information: ______
Action: (granted ______) (denied ______)
Notification: by: ______ date: ______

## APPENDIX D

## STATE OF VERMONT
## DEPARTMENT OF WATER RESOURCES

### GENERAL INFORMATION AND INSTRUCTIONS FOR SUBMITTING APPLICATION FOR PERMIT TO DISCHARGE WASTES INTO THE WATERS OF THE STATE AFTER JULY 1, 1971

### 1. STATUTORY REFERENCES

The Vermont General Assembly has made substantial revisions to the state water pollution control statutes. The changes are contained in Act No. 252 of the Acts of 1969 (Adjourned Session) which amends 10 V.S.A. Chapter 33, Subchapter 1. The amendments, most of which took effect on April 4, 1970, regulate or prohibit certain discharges which previously were permissible and impose certain specific responsibilities upon *all* persons discharging treated or untreated wastes into waters of the state.

Among its provisions, the act requires that on or after July 1, 1971, no person shall discharge *any* waste, substance or material (treated or untreated) into the waters of the state without first obtaining a *permit* for such discharge from the Department of Water Resources. (See 10 V.S.A. § 909(b). Two types of permits are provided for in the statute: (1) *Discharge Permit:* authorizes discharge of wastes which will not reduce the quality of the receiving waters below their established classification; (2) *Temporary Pollution Permit:* authorizes discharge of wastes which will reduce the quality of the receiving waters below their established classification in certain cases for a limited period of time necessary to design, construct and place into operation a treatment facility or alternate waste disposal system subject to payment of assessed pollution charges. (See 10 V.S.A. §§911a, 912a.) In addition applicants are required to pay a fee to defray the expense of reviewing and evaluating an application. (See 10 V.S.A. § 911a, § 912a.)

All permits previously issued by the Water Resources Board will be revoked on July 1, 1971. Any person discharging waste substances or materials into the waters of the State after July 1, 1971, without a discharge permit or temporary pollution permit, will be subject to the enforcement provisions of the statute (see V.S.A. §§917a,918).

Pertinent sections of Chapter 33, Subsection 1 are:

## § 901. DEFINITIONS

Whenever used or referred to in this chapter, unless a different meaning clearly appears from the context:

(1) "Board" means the Vermont Water Resources Board;

(2) "Department" means the Department of Water Resources;

(3) "Discharge" means the placing, depositing or emission of any wastes, directly or indirectly, into the waters of the state;

(4) "Person" means any individual, partnership, public or private corporation, municipality, institution or agency of the state, and includes any officer or governing or managing body of a partnership, association, firm or corporation;

(5) "Public Interest" means that which shall be for the greatest benefit to the people of the state as determined by the standards set forth in subsection (3) of section 903 of this title;

(6) "Waste" means effluent, sewage or any substance or material, liquid, gaseous, solid or radioactive, including heated liquids, whether or not harmful or deleterious to waters;

(7) "Waters" shall include all rivers, streams, creeks, brooks, reservoirs, ponds, lakes, springs and all bodies of surface waters, artificial or natural, which are contained within, flow through or border upon the state or any portion thereof.

## § 909. PROHIBITIONS

(a) No person, without written authorization of the board, shall discharge into the waters of the state any waste which by itself or in combination with the wastes of other sources reduces the quality of the receiving waters below the classification established for them. This subsection shall not prohibit the proper application for fertilizer to fields and crops. On July 1, 1979, this subsection shall expire and deemed repealed.

(b) On and after July 1, 1971, no person shall discharge any waste, substance or material into waters of the state without first obtaining a permit for such discharge from the department. This subsection shall not prohibit the proper application of fertilizer to fields and crops.

## § 911a. DISCHARGE PERMITS

(a) Any person intending to discharge waste into the waters of the state on and after July 1, 1971, shall make application to the department for a discharge permit. Application shall be made on a form prescribed by the department and shall contain such information as the department may therein require. An applicant shall pay to the department at the time of submitting his application such amount as the board shall by rule determine reasonable to defray the expense of reviewing and evaluating an application.

(b) The department shall consider each application and shall grant or deny the requested permit within sixty days from the date of receipt of the application. The department may require the applicant to submit any additional information which it considers necessary and may refuse to grant a permit until such time as the information is furnished and evaluated.

(c) If the department finds that the proposed discharge will reduce the quality of the receiving waters below the classification established for them, it shall deny the application and refuse to issue a permit. If the department finds that the proposed discharge will not reduce the quality of the receiving waters below the classification established for them, it shall issue a discharge permit.

(d) A discharge permit shall:

(1) specify the manner, nature, volume and frequency of the discharge permitted;

(2) require proper operation and maintenance of any pollution abatement facility necessary in the treatment or processing of the waste by qualified personnel in accordance with standards established by the board;

(3) contain such additional conditions, requirements and restrictions as the department deems necessary to preserve and protect the quality of the receiving waters; and

(4) be valid for the period of time specified therein.

(e) A discharge permit may be renewed from time to time upon application to the department. No renewal permit shall be issued if the department finds that the proposed discharge will reduce the quality of the receiving waters below the classification established for them.

### § 912a. TEMPORARY POLLUTION PERMITS

(a) A person who does not qualify for or has been denied a waste discharge permit under section 911a of this title may apply to the department for a temporary pollution permit. Application shall be made on a form prescribed by the department and shall contain such information as the department may therein require. Such person shall pay to the department at the time of submitting the application such amount as the board shall by rule determine reasonable to defray the expense of reviewing and evaluating each application. The department may require such person to submit any additional information it considers necessary for proper evaluation.

(b) Using whatever means it deems proper, the department shall give notice to the people resident in the drainage area of the receiving waters for the proposed discharge of the time in which they may present written objections to the proposed discharge.

(c) After consideration of the application, any additional information furnished and all written objections submitted, the department shall grant or deny a temporary pollution permit. No such permit shall be granted by the department unless it affirmatively finds:

(1) the proposed discharge does not qualify for a discharge permit;

(2) the applicant is constructing, installing or placing into operation or has submitted plans and reasonable schedules for the construction, installation or operation of an approved pollution abatement facility or alternate waste disposal system, or that the applicant has a waste for which no feasible and acceptable method of treatment or disposal is known or recognized but he is making a bona fide effort through research and other means to discover and implement such a method;

(3) the applicant needs permission to pollute the waters of the state for a period of time after July 1, 1971 necessary to complete research, planning, construction, installation or the operation of an approved and acceptable pollution abatement facility or alternate waste disposal system.

(4) there is no present, reasonable, alternative means of disposing of the waste other than by discharging it into waters of the state;

(5) the denial of a temporary pollution permit would work an extreme hardship upon the applicant;

(6) the granting of a temporary pollution permit will result in some public benefit;

(7) the discharge will not be unreasonably destructive to the quality of the receiving waters.

## § 917a. ENFORCEMENT

Notwithstanding any other provision or procedure set forth in this subchapter if the board finds that any person has discharged or is discharging any waste in violation of this subchapter or that any person has failed to comply with any provision of any order or permit issued in accordance with this subchapter, it may bring suit in equity in the Washington county court of chancery or in any county where the discharge or non-compliance has occurred to enjoin such discharge and obtain compliance. Such suit shall be brought by the attorney general in the name of the state. The court of chancery may issue a temporary injunction or order in any such proceedings and may exercise all the plenary powers available to such court in addition to the power to:

(1) enjoin future discharges;

(2) order the design contruction, installation or operation of pollution abatement facilities or alternate waste disposal systems;

(3) order the removal of all wastes discharged and the restoration of water quality;

(4) fix and order compensation for any public property destroyed, damaged or injured, and;

(5) assess and award punitive damages.

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## § 918. PENALTY

Any person who violates any provision of this subchapter or who fails, neglects or refuses to obey or comply with any order or the terms of any permit issued in accordance with this subchapter, shall be fined not more than $10,000 or be imprisoned not more than five years, or both. Each violation shall be a separate and distinct offense and, in the case of a continuing violation, each day's continuance thereof shall be deemed a separate and distinct offense.

---

### Single vs. Multiple Discharges

In the event that a discharger has more than one waste effluent stream or point discharging from the same activity, a separate permit will be required for each such discharge. The discharger may submit a single application form for the *activity* involved, but must include separate schedules describing each waste effluent discharge. Examples of single activities include municipalities, resorts, and industrial plants, provided that the resort or plant is at a single location. If a company owns more than one resort or plant at separate locations, each is a separate activity. An individual residence or commercial or public building which have only sanitary wastes, are not connected to a municipal sewerage system, and discharge wastes into the waters of the State, are other examples of single activities.

Types of independent effluent streams which may be associated with a single activity will vary with type of activity. For example, a municipality may have separate collection systems leading to separate treatment facilities. An industrial plant may discharge sanitary wastes, process water and cooling water separately.

The purpose of reporting each independent effluent discharge separately is that waste materials associated with each can be quite different, thus requiring different types of treatment facilities. The resultant effluents must therefore be considered independently to determine whether they cause the receiving waters to be degraded below their classifications, and if so to determine the appropriate treatment and the amount of the pollution fee in the event a temporary pollution permit is granted.

### Application Procedure

The department must first consider whether each discharge is eligible for a discharge permit. If a discharge permit is denied, the applicant will be so informed and may then request a temporary pollution permit. Before the department acts on the latter, it must obtain certain additional information including any plans and schedules for the construction, installation and operation of an approved pollution abatement facility or alternate waste disposal method. It must also give notice to the people resident in the drainage area of the receiving waters for the proposed discharge of the time in which they may present written objections to the proposed discharge. To minimize delay to those dischargers who will operate under a temporary pollution permit, schedules attached to the application form contain two parts. The first part must be completed for either permit, while the second part need only be completed for consideration for a temporary pollution permit.

If the applicant believes he cannot qualify for a discharge permit, he should complete both parts of the Schedule appropriate to his activity. Completing the second part will in no way affect his possible qualification for a discharge permit. In any event he will be notified by the department of its decision relative to the granting of a discharge permit, at which time, if a discharge permit is denied, he may request the department to process his application for a temporary pollution permit.

### Schedules

The application form consists of a basic section for identifying applicant, type of activity, and independent effluent streams or points for which separate Schedules are to be attached. Three types of Schedules are available: Schedule A for municipal discharges, and Schedule B for industrial, resort and institutional discharges, and Schedule C for wastes from a single discharge and not exceeding 1000 gallons per day.

### Application Fee Payments

The board has adopted the following application fees, payment of which must accompany the application:

(Pending Board Action)

### Appeal Rights

Any person or party in interest aggrieved by an act or decision of the department pursuant to Title 10, V.S.A., Chapter 33, Subchapter 1, may appeal such act or decision to the water resources board within thirty days from the date thereof (§ 914a). An appeal filed pursuant to this section shall not stay the effectiveness of any act or decision of the department pending determination by the board.

Any person or party in interest aggrieved by any order or decision of the board pursuant to this subchapter may appeal such order to decision within thirty days from the date thereof to the court of chancery of any county in which the receiving waters are located (§ 915). An appeal filed pursuant to this section shall not stay the effectiveness of any order or decision of the board pending determination by the court unless the court so orders.

### Assistance

Persons having questions regarding the application may write or call the Department of Water Resources, Montpelier, Vermont, for further clarification.

### Detailed Instructions for Completing Application and Schedule Forms

NOTE: Answer questions on the basis of the waste discharge which will take place on and after July 1, 1971; not on the basis of present discharges.

### BASIC APPLICATION

| | |
|---|---|
| Lines 1, 2, 3, 6 and 8. | Self-explanatory |
| Line 4. | Legal person of Applicant. Select from the following: individual, partnership, public corporation, private corporation, municipality, institution of the state, agency of the state, Federal agency; or describe if not listed herein. |
| Line 5. | Name of activity. If a municipality, enter "municipality." For others, enter the name of the plant, mill, resort, building, operation, etc., to which the application applies. |
| Line 7. | Independent Discharge Systems.<br>Enter a brief description which will serve to identify and distinguish each system. For municipalities, typical descriptions may be "Main Street treatment plant." "Oak Street intercepter sewer outfall." For industrial plants, typical descriptions may be "sanitary waste system," "combined wastes system," "process wastes," "cooling water," etc. At least one system must, of necessity, be listed for each application. Include any systems which are solely for the purpose of collecting and discharging storm runoff as well as combined sanitary-storm water systems. For individual residences or buildings give street address. |

Special case for municipalities – if all or part of the corporate entity is not served by a municipal sewage collection system and the dischargers who are not served discharge wastes into the surface waters of the State (e.g., individual outfalls into a stream), the municipality may file a collective permit application on behalf of all such dischargers, but in doing so it must accept responsibility for all related fee payments. If this manner of filing is elected, complete line 7 as follows:

(a) Make a separate entry for each treatment plant which will serve a portion of the municipality, if any.

(b) Make a separate entry for the collective application, using a description such as "collective report for individual discharges." This may include business buildings and commercial establishments normally to be included in a waste collection system, but not major industries.

(c) If there are major industries whose wastes are proposed to be included in a future municipal waste disposal system, and with whom agreements have been reached regarding such future collection, they may be included in the municipal permit application by making a separate entry in line 7. This action will shift the responsibility for obtaining and holding a permit from the industry to the municipality. If this option is elected by the municipality, include copies of documents attesting to the agreement.

NOTE: Under this special case, a separate schedule must be completed for each entry in line 7. Use Schedule A for municipal discharges, and Schedule B for industrial and institutional discharges. If future events result in changes or expected changes to the information reported herein the application or any of the schedules, such changes must be reported immediately to the Department of Water Resources and amended forms submitted.

## SCHEDULE A – Municipal Discharges

### PART I

| | |
|---|---|
| Line A-1 | Name (same as Line 1, Basic Application) |
| Line A-2 | Discharge to which schedule applies. Enter sequence number and description as listed in line 7, Basic Application. |

| | |
|---|---|
| Line A-3 | If the entire corporate entity is served by a sewage collection and disposal system, enter "entire (city) of ." If the line entry pertains to only a portion of the municipality, name the streets served or include a map showing the areas served. |
| Lines A-4, A-5 | Self-explanatory |
| Line A-6 | If wastes not reported on schedule are covered by another entry in line 7, enter "see separate schedule." If remaining wastes do not require permit action, include reason (e.g., their disposal is to the ground via septic tanks and leaching fields). |
| Line A-7 | If wastes are collected in either a sanitary sewer system or a combined sanitary and storm sewer and are limited to sanitary and kitchen wastes, indicate "no." If other wastes are involved, indicate "yes." |
| Line A-8 | Basis should be on normal volume of discharge excluding storm runoff. |
| Line A-9 | Include only those users whose discharge will be included in the municipal system as of July 1, 1971. Any major users whose wastes are proposed to be collected in a future collection system and for whom the municipality elects to include in their application must be reported on a separate schedule (see Instructions for line 7 above). |
| Lines A-10, A-11 | Self-explanatory |
| Line A-12 | In general, no treatment means that the wastes are discharged directly into a stream from a sewage collection system. "Primary" treatment means that a settling tank is used to remove settleable solids, with the remaining liquid discharged after chlorination. "Secondary" treatment includes primary treatment but in addition uses aeration tanks or trickling filters to provide reduction of the organic load remaining in the liquid after solids removal. |
| Lines A-13 to A-16 | Self-explanatory |

| | |
|---|---|
| Line A-17 | When indicating the distance of the discharge from a fixed landmark, whenever possible reference to the stream network, i.e., miles or feet upstream or downstream of a bridge, dam or confluence of two streams. |

## PART II

| | |
|---|---|
| Lines A-18, A-19 | These lines need only be completed if the application is for or may be for a temporary pollution permit. Monetary values must be included for the purposes of determining the pollution fee and any credits against such fee. The questions are generally self-explanatory, but if clarification is desired, contact the Department of Water Resources. |

## SCHEDULE B – Industrial and Institutional

| | |
|---|---|
| Line B-1 | Name (same as line 1, Basic Application). |
| Line B-2 | Discharge to which schedule applies. Enter sequence number and description as listed in line 7, Basic Application. |
| Line B-3 | Check type of activity or activities which generates the wastes involved. Write in and check any activity not listed. If wastes from several activities are collected in a common collection system prior to treatment and disposal, indicate all such activities. |
| Line B-4 | The Department must know the type of treatment and manner of disposal of the treated wastes in order to determine the applicant's eligibility for a discharge permit. The volume, frequency and characteristics of the wastes will be covered in lines B-5 and B-6. Use line B-4 to describe the type of treatment facility which will be operational on and after July 1, 1971, its rated capacities, efficiencies, methods of operation, and disposal methods. This can be done in narrative style and augmented by sketches, plans or manufacturers' specifications. Be sure to describe each separate component in the system and the flow sequence connecting them. For example, if several settling basins are used in series and/or parallel configuration, indicate the flow through the system, the dimensions of each basin, and the method used for removing settled matter. |

Be sure to include in the description the point at which the treated or untreated wastes enter the waters of the State. For example, if the effluents are first discharged into a ditch or swamp, indicate this and the point at which these drain into a stream or lake banks as a result of ground disposal.

**Line B-5**

*Volume* and frequency of waste discharge. If you use Option A, the Department will calculate the volume, frequency and composition of the wastes based on standard values for the activities involved and the type of treatment reported in line B-4. Persons using Option A need not complete Table B-1 nor B-2 of line B-6.

If you use Option B, enter the total *volume* of wastes in gallons to be discharged during each of the time periods shown in Table B-1. If your activity is essentially constant during all months of the year, check the space at the top of Table B-1 and complete the January line only. If the rate of discharge (i.e., gallons per minute) varies considerably during any time period, explain in the space below Table B-1.

**Line B-6**

Enter the *maximum concentrations* of pollutants associated with the discharge volumes after treatment (if any) reported in line B-5. The rates reported in Table B-2 will be the basis of evaluation by the Department, and if a discharge permit or a temporary pollution permit is granted, the rates will also be designated on the permit as the maximum allowable.

If the heat added to the waste water is due only to the influence of normal room temperatures and/or sanitary and domestic uses, enter "none added" in the line "temperature of discharge water."

Under the entry "chemicals," include metal ions, fluorides, radioactivity chlorides, nutrients, toxic material, etc. Submit copies of laboratory tests if available.

**Lines B-7, B-8**

Self-explanatory

| | |
|---|---|
| Line B-9 | When indicating distance of discharge from a fixed landmark whenever possible reference to the stream network. i.e., miles or feet upstream or downstream of a bridge. dam, or confluence of two streams. |

## PART II

| | |
|---|---|
| Lines B-10 to B-13 | These lines need only be completed if the application is for or may be for a temporary pollution permit. Monetary values must be included for the purposes of determining the pollution fee and any credits against such fee. The questions are generally self-explanatory, but if clarification is desired, contact the Department of Water Resources. |

## SCHEDULE C – Domestic and Commercial Discharges

## PART I

| | |
|---|---|
| Line C-1 | Name (same as line 1, Basic Application) |
| Line C-2 | Discharge to which schedule applies. Enter sequence number and description as listed in line 7, Basic Application. |
| Lines C-3, C-4, C-5 | Self-explanatory |
| Line C-6 | If entire discharge is to the ground, as by leaching fields, enter "none." |
| Line C-7 | When indicating distance of discharge from a fixed landmark, whenever possible reference to the stream network. i.e., miles or feet upstream or downstream of a bridge. dam, or confluence of two streams. |

## PART II

| | |
|---|---|
| Lines C-8, C-9 | These lines need only be completed if the application is for or may be for a temporary pollution permit. The questions are generally self-explanatory, but if clarification is desired, contact the Department of Water Resources. |

## APPENDIX E

# EXAMPLES OF ACTUAL APPLICATION OF EFFLUENT FEE OR SEWER CHARGES SYSTEM

## 1. THE RUHR SYSTEMS

The literature on the Ruhr effluent fee systems is extensive, and mainly available in German. The present description is based upon a review of the very few English language sources.[1]

The Ruhr systems for water management have a long history of evolution going back to the turn of the century. The associations that have been formed are organized on a drainage basin district concept with voting power distributed in accordance to each member's financial contribution. Members may be local governments responsible for municipal waste disposal, or industries. Thus, the concept of a joint regulatory agency managed cooperatively by local government and industry has been achieved. Membership in each of the eight major Ruhr basin agencies is compulsory.

In managing the water quality, the Ruhr agencies provide a variety of management services. These include construction and operation of treatment facilities, regulation of river flows through reservoir control, monitoring of the river quality, assisting in the identification of processes other than treatment which reduce wastes discharged on an industry-by-industry basis, and providing marketing services for materials salvaged from wastes treated by each industry or by the agency. In addition, the agencies regulate the distribution of water, and to a certain extent, water related land use.

Within the context of the Ruhr basin agencies, whose function is to completely manage water quality improvement in each region independently, as well as to manage accommodations with each of the other Ruhr agencies, the purpose of the effluent fee system is to distribute the costs of all activities in which the agencies engage to each of the members on a mutually acceptable and equitable basis. Thus, each of the eight regions has developed its own formula for cost distribution through the leveling of some form of effluent fee.

According to G.M. Fair,[2] "One general provision of the statutes that has played a large role in successful and efficient operation is the requirement that the costs of constructing and operating the system are to be borne by the members responsible for them as well as by those who benefit." While some limited information was available regarding formulas for distributing the costs to those who pollute, no detailed indication was obtained regarding the mechanism for cost allocation to those who benefit, or the identification of beneficiaries.

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[1] Kneese and Bower, *Managing Water Quality*, Johns Hopkins Press, 1968; G.M. Fair, "Pollution Abatement in the Ruhr District," in *Comparisons in Resource Management*, Henry Jarrett (ed.), Johns Hopkins Press, 1961.

[2] G.M. Fair, *op. cit.*

In developing formulas to compute the contribution of each individual polluter, at least two of the Ruhr agencies elected procedures that reduce a complex vector of wastes generated to a uniformly comparable index. For example, the Emschergenossenschaft-Lipperverband (Emsher and Lippe River Basin Agencies) combine several measurements of waste quantity and concentration in the effluent to a uniform dilution factor, which then becomes the basis for fee computation. The formula used is:

$$D = 1 + \frac{S}{S_p} + \frac{1}{2}\frac{B}{B_p} + \frac{1}{2}\frac{(P-30)}{P_p} + F$$

$D$ = dilution factor

$S$ = settleable solids (cm$^3$/liter)

$S_p$ = permissible S

$B$ = BOD$_5$ in mg/liter after sedimentation

$B_p$ = permissible BOD

$P$ = potassium permanganate oxygen (COD) used in mg/liter after sedimentation

$P_p$ = permissible P

$F$ = toxicity to fishlife by a special dilution method based upon 49 hours with no observed fish damage.

Clearly, application of the above formula requires that laboratory tests be performed routinely and periodically on all effluents to which a charge will be leveled. In addition to the above calculation, other factors such as heat, temperature of the effluent, and strength of effluent are evaluated. Further technical details were not given in the sources studied.

The Ruhrverband (Ruhr River Association) on the other hand employs a population equivalent basis, where the population equivalent of each effluent is determined by a standard laboratory test, in which the number of liters of effluent that represents one population equivalent is determined, using a special procedure developed in the Ruhrverband laboratories for that purpose.

In both of the above methods, no actual determination is made of any of the common or unusual chemical compounds that constitute industrial wastes. Rather the degrading effect of all such wastes, whatever they are, is determined using a standard procedure in which the actual chemical composition is not determined.

## 2. THE SEINE-NORMANDY BASIN FINANCIAL AGENCY

The effluent fee system was established by the Board of Directors of the Seine-Normandy Basin Financial Agency Board of Directors in a resolution dated October 9, 1968.[1] The purpose of the fee is to provide an economic incentive for polluters to reduce their waste discharges through treatment or other means.

Fees are computed according to a "basis," which will be described below. A polluter may elect to have his basis computed from standard estimating tables providing by the agency, or at his own expense to determine his basis according to very specific instruction for effluent sampling and laboratory testing.

Essentially, the system is a uniform charge weighted by geographic location which is analogous to a river classification system.

"Basis" = quantity of pollutants in 1 normal day of maximum discharge month *minus* daily amounts of same material in the intake.

The basis has two components:

Suspended Solids (kilograms)
Oxidizable material
Oxidizable materials = COD + 2(BOD)/3 (kilograms)

The fee structure per kilogram/day of pollution added is specified by geographic zone.

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[1] Resolution No. 68-14 of October 9, 1968 by Board of Directors – Seine-Normandy Financial Agency, translated at Arthur D. Little.

| Zone | Annual Charge Per Kilogram (Francs) | Dollars/Kilo | $/Pound |
|---|---|---|---|
| 1 | 22.50 | 4.50 | 2.00 |
| 2 | 18.50 | 3.60 | 1.64 |
| 3 | 15.00 | 3.00 | 1.36 |
| 4 | 15.00 | 3.00 | 1.36 |
| 5 | 7.50 | 1.50 | 0.68 |

The minimum basis for a tax is 30 kilogram/day. Considering that the above charges are based upon the average day in the maximum polluting month, and assuming that the net annual pollution loading is equal to 200 times the average load in the maximum polluting month (this will vary with differing seasonal discharge patterns of different polluters) the approximate net cost per pound becomes ¢[1.02, 0.82, 0.68, 0.68, 0.34].

Two pollution classes are defined for standard estimation purposes:

1. Household – includes all towns and industries who claim less than 5000 $m^3$/year of intake meter.

2. All other polluters.

A "[DIMENSION]" vector is defined for purposes of fee estimation by standard table. The components of [DIMENSION] to be considered are defined by the standard table for each class of polluter. [DIMENSION] may contain

- daily production of a produce by weight (may be raw material processed or weight after processing)

- daily volume of water utilized

- number of people employed by the establishment.

For each characteristic [DIMENSION] there is a standard amount in grams of suspended and oxidizable materials assumed to be brought in by each polluter, per unit of the [DIMENSION] component.

A reduction of the above computation is allowed when there is final waste treatment. The reduction is equal to the estimated efficiency of the treatment method with respect to suspended solids and oxidizable materials. The efficiency allowance schedule consists of 10-15% for primary and secondary settling of suspended solids, and 20% to 100% for BOD reduction when purification takes place. No reduction in BOD load is allowed when settling processes alone are used.

Polluters may qualify for tax cuts under the following conditions:

- $[\frac{\text{tax due}}{\text{number employed}}]$ exceeds a certain amount
- current pollution level existed prior to May 1, 1968
- request contains – number of jobs, total salaries paid, added value (salaries plus related expenses), finance charges and gross profits prior to tax
- a memo explaining anticipated progress in waste processing together with proposed Financial plan.

## 3. THE CZECHOSLOVAK SYSTEM

The Czech effluent fee system was enacted by government decree on March 12, 1966. The information outlined herein is based on a crudely translated portion of that decree.[1] Evidently, the purpose of the system is to provide economic incentives for polluters to treat waterborne wastes to "sufficient" levels.

There are two bases for computing pollution charges. One is a cost of treatment, where the degree of treatment required is determined by the "River Board" agency in a manner not precisely specified in the law. The other basis is related to each polluter's contribution to river quality deterioration as computed under standardized (i.e., simplified) assumptions regarding the physical dynamics of pollution. Thus, there is a basic so-called "indemnity" charge derived from annualized cost of treatment, upon which is imposed a "surtax" based upon contribution to stream quality deterioration.

The basic charge may be determined from standard tables of theoretical cost of treatment, or from actual engineering design documents provided by the polluter.

The basic indemnity is defined by:

$$B = M_1 \times BOD + M_2 \times SS$$

---

[1] Degree of the Czech Government No. 16, March 12, 1966, Concerning Indemnities for Discharging Untreated or Insufficiently Treated Waste Waters into Streams.

Where:

B = basic indemnity

BOD = biochemical oxygen demand

SS = suspended solids

$M_1$ = estimated per unit cost of removal of BOD expressed in Czech crowns/kg of BOD

$M_2$ = estimated per unit cost of removal of SS expressed in Czech crowns/ton of SS.

At the discretion of the River Board charges may not apply when loading does not exceed:

50 Tons BOD per year or
300 Tons SS per year

Credit for storage and controlled discharge is given.

When $M_1$ and $M_2$ are not based upon actual engineering estimates, the following formulas are applied:

$$M_1 = 5 - \text{lo}\ X$$
$$M_2 = 2.75 - 0.25 \log Y$$

X = tons per year of BOD
Y = tons per year of suspended solids.

In addition to the basic indemnity, there is a surtax based upon the degree of stream water quality deterioration caused by the discharger.

1 basic unit of deterioration for BOD = 0.25 mg/l
1 basic unit of deterioration for SS = 0.50 mg/l

The calculated deterioration in stream quality caused by a discharger is based on the load of pollutants introduced by the discharger and the stream flow guaranteed for 355 days in an average year and is expressed in mg/l of BOD and SS. Thus, if $D_1$ and $D_2$ represent the calculated stream quality deterioration for BOD and SS respectively for a given discharger, then

$$\frac{D_1}{0.25\ \text{mg/l}} \text{ and } \frac{D_2}{0.50\ \text{mg/l}}$$

expresses the calculated deterioration as a fraction of a basic unit of deterioration. This fraction is then applied to the "basic indemnity" to obtain the surtax. Thus where T = the surtax.

$$T = \frac{D_1}{0.25\ \text{mg/l}}(M_1\ .\ \text{BOD}) + \frac{D_2}{0.50\ \text{mg/l}}(M_2\ .\ \text{SS})$$

The technical basis for computing the "basic unit of deterioration" was not specified in the Czech decree except to indicate that it represents one twentieth of the difference between standards for water quality in "Class IB" waters and similar standards for "Class II" waters. The decree also specifies that no single surtax will be greater than 100% of the basic indemnity and grants authority to the River Board to adjust the calculated surtax down to 10% of the basic indemnity in justified cases.

Adding the basic indemnity and surtax together gives the total pollution charge applicable to dischargers of untreated or insufficiently treated wastes under the Czechoslovak system:

$$\text{Total Charge} = (1 + \frac{D_1}{0.25\ \text{mg/l}})\ M_1\ .\ \text{BOD} + (1 + \frac{D_2}{0.50\ \text{mg/l}})\ M_2\ .\ \text{SS}$$

## 4. NORTH AMERICAN SEWER CHARGE SYSTEMS

There are various districts in the United States and Canada, where the district agency operates a regional sewage treatment plant, and covers at least a portion of the cost of treatment by leveling a charge upon each contributor. The rationale for the charge in each case is to collect from each discharger a sum proportional to the actual cost of processing his wastes. Two examples of sewer charge formulas in current usage are described below.

The Greater Winnipeg[1,2] Sanitary District has adopted the following formula:

$R_i = [A] R_n + [B] R_c + [C] R_x$

$R_i$ = surcharge per 1000 gallons of sewage

$R_n$ = unit charge based on normal sewage treatment

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[1] Kneese and Bower, *Managing Water Quality*, Johns Hopkins Press, 1968.

[2] A. Penman, "Wastewater System for the Metropolitan Corporation of Greater Winnipeg," Journal of the Water Pollution Control Federation, March 1967.

$R_c$ = unit charge based on chlorine requirements

$R_x$ = unit charge based on additional treatment costs

A = function of suspended solids concentration and BOD in the effluent

B = function of chlorine demand

C = function of quantity of materials requiring special treatment.

The Allegheny County Sanitary Authority[3] (Pennsylvania) established a schedule of basic rates per 1000 gallons of effluent to which a factor is applied.

$$F = 1 + 0.15\ [\frac{0.75\ (SS - 275)}{275} + \frac{0.25\ (BOD) - 300)}{300}]$$

F = Factor
SS = Suspended solids in mg/l
BOD = Biochemical oxygen demand in mg/l

To this is added a chlorine surcharge.

$R_c$ = Chlorine surcharge in ¢/1000 gallon
$P_c$ = Price per pound of chlorine
C = Chlorine demand in mg/liter.

The basic rate is determined on a volumetric basis according to the following schedule:

| | Water Used Per Quarter Year (thousand gals.) | Basic Rate ¢/1000 Gallons |
|---|---|---|
| First | 100 | 30 |
| Next | 1,000 | 25 |
| Next | 2,500 | 20 |
| Excess Over | 3,600 | 15 |

While the Winnipeg system includes the cost of special treatment that might be required for industrial wastes, the Allegheny system as reported does not. Presumably, substances that would interfere with biological treatment process are simply prohibited.

Maystre and Geyer[1] have recently published the results of an extensive survey of sewage charges used by municipal plants receiving industrial effluents. They report that by 1977 50% of all municipal waste treatment plants will be receiving industrial effluent. Sewer charge formulas are reported for 28 cities with a population exceeding ten thousand, out of 221 cities sampled. Major municipalities with sewer charge formulas include Denver, St. Louis, Cincinnati, Houston, and Dallas. The majority of the charge systems date from 1960. The authors report "The form, length and content of the ordinances portray an amazing variety, some being just one page, others being encyclopedic." Various combinations of uniform fees, dilution factors, population equivalents, or other basis for fee determination are reported upon.

Wood[2] reports extensive use of sewer charges based upon incoming effluents in Great Britain as well. While he provides a general review of sewer charge practice in Great Britain, no examples of formula are stated.

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[1] Maystre and Geyer, "Charges for Treating Industrial Wastewater in Municipal Plants," Journal of the Water Pollution Control Federation, July 1970.

[2] Richard Wood, "Wastewater and Rates and Service Charges in Great Britain," Journal of the Water Pollution Control Federation, December 1969.

# APPENDIX F

## ESTIMATION OF TREATMENT COSTS

The cost of treating wastewater is made up of two parts: actual recurring operation and maintenance for labor, chemicals and utilities, and debt service on the capital invested in the plant. The total annual cost for a specific case can be expressed as in Equations (1a) and (1b) below. For municipalities, this cost is the actual net cost of treatment. For industrial firms, the net treatment cost differs from Equations (1a) and (1b), since some of the expenditures are deductible from taxable profits. The actual out-of-pocket cost to the firm is discussed in Section 2D of this Appendix.

For both municipalities and industrial firms, an effluent fee equal to cost of treatment should be based on Equation (1), since the industrial tax savings are automatically returned to the firm in the course of its dealings with the Internal Revenue Service.

The total annual cost of treatment is given by:

$$T = \beta y C'_c + C'_o \qquad (\$/\text{year}) \qquad (1a)$$

where

$\beta$ = $\$$ debt service cost per year/$\$$ capital invested:

$\beta$ is a function of the interest rate (I) and the period of amortization (N) according to

$$\beta = \frac{(I) \quad (1+I)^N}{(1+I)^N - 1}$$

y = fraction of the capital cost borne by the treater: $y=1$ for industries and $0.25 < y < 1.00$ for municipalities receiving state and federal grants

$C'_c$ = capital cost of the treatment facility in $\$$

$C'_o$ = annual operating cost in $\$$ per year

For some purposes, it is easier to compute the cost from normalized capital and operating cost figures expressed on a basis of per pound of BOD treated per day. The total annual cost expression is:

$$T = (\beta y C_c + C_o) \quad (8.33) \quad V \quad (L - L_o) \quad (\$/\text{year}) \qquad (1b)$$

where $\beta$ and y are as previously defined and

$C_c$ = capital cost of treatment facility in $/lb BOD treated per day

$C_o$ = operating cost in $ per year/lb BOD treated per day

V = average wastewater flow in MGD (8.33V = million lb per day)

L = pollutant concentration in wastewater in ppm BOD

$L_o$ = effluent or residual concentration in ppm BOD.

In estimating T, we will normally know $\beta$, y, V, L and $L_o$. We will need to estimate $C_c$ and $C_o$, or $C_c^1$ and $C_o^1$.

## 1. TREATMENT OF MUNICIPAL WASTES

General correlations of normalized capital and operating costs for treatment of municipal wastes are given in the literature.

### A. Capital Cost ($C_c$)

Shah and Reed(1) surveyed 563 sewage treatment plants in 1969 and analyzed the construction cost data for several kinds of primary and secondary treatment by multiple regression. Their equation for secondary treatment plants is:

$$\ln C_c = 8.32 + 0.467 \ln P - 0.782 \ln V + 0.015 D_1 + 0.120 D_2 \qquad (2)$$

where

$C_c$ = capital cost/design MGD in 1957-59 dollars

P = design population equivalents

V = average flow in MGD

$D_1$ and $D_2$ are dummy variables where

$D_1 = 0, D_2 = 0$ for standard rate trickling filter (SRTF) plants

$D_1 = 1, D_2 = 0$ for high rate trickling filter (HRTF) plants

$D_1 = 0, D_2 = 1$ for activated sludge (AS) plants.

This equation can be converted to the desired form (i.e., $C_c = F(V,L)$) by use of the following equations:

$$P = \frac{8.33\ VL}{b} \tag{3}$$

where b = nominal BOD load per person per day (0.17 lb BOD per person per day) and

$$C_c = C_c \frac{1}{8.33L} \tag{4}$$

Taking anti-logs of both sides of Eq. (2), substitution of Eqs. (3) and (4), and multiplication by 1.38 to express cost in current dollars yields the following cost equations:

$$C_c = A\ V^{-0.315}\ L^{-0.533} \quad (\$/\text{lb BOD per day}) \tag{5}$$

where

A = 4707 for AS plants
4162 for SRTF plants
4239 for HRTF plants

This equation shows the economies of scale (the negative exponent on V) and of treating a concentrated effluent (the negative exponent on L).

The 1969 *Cost of Clean Water*(a) shows comparable costs for AS plants. The cost per capita in 1957-59 dollars is shown as a function of population served in Figure 5, p. 62, of Volume I. Values from this figure were put on the same basis as Eq. (5) by dividing the cost figures by 0.17 lb BOD per person per day and multiplying the population figures by 100 gallons per person per day. The resulting values multiplied by 1.38 to reflect current dollars, are shown in Figure 1.

Values resulting from Eq. (5) are also shown in Figure 1. The normal concentration of municipal sewage was assumed to be 250 ppm. Substituting L = 250 ppm into Eq. (5) yields

$$C_c = B\ V^{-0.315} \quad (\$/\text{lb BOD per day}) \tag{6}$$

B = 247.7 for AS plants
219.1 for SRTF plants
223.1 for HRTF plants

These equations are plotted in Figure 1.

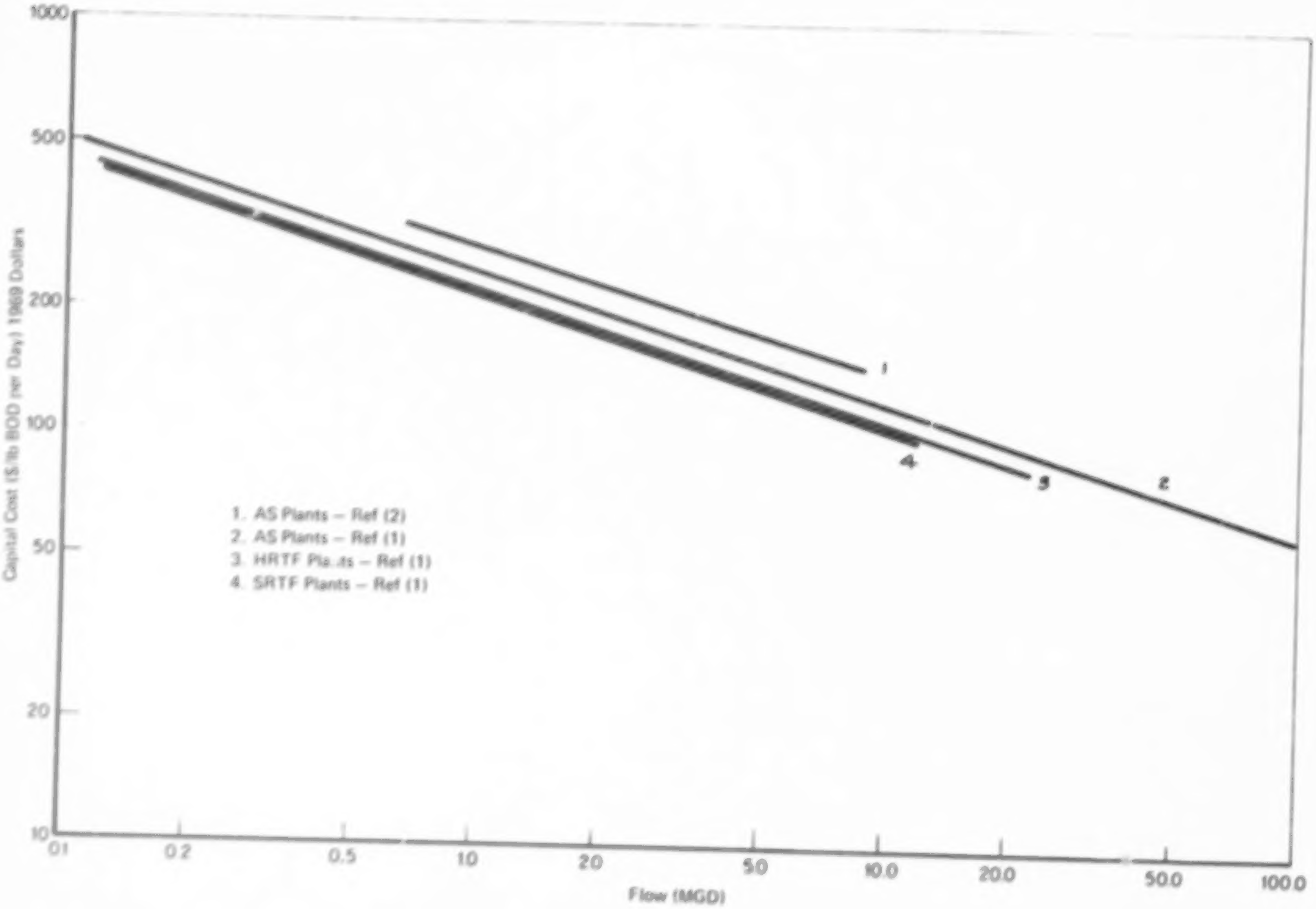

FIGURE 1 CAPITAL COST OF SECONDARY PLANTS

The two lines for AS plants agree within about 20%, which is within the accuracy of the conversion factors used to put the data on a common basis.

## B. Operating Costs $C_o$

Michel, Pelmoter and Palange(3) analyzed operating cost data gathered in 1500 audits over the period from 1962 to 1964. They correlated costs against flow for each type of treatment plant using equations of the form

$$\log C = \frac{1}{a = b \log V} \tag{7}$$

Costs included are those associated with labor, utilities and chemicals. Values associated with secondary treatment from their analysis put on a basis of lb BOD per day and multiplied by 1.18 to reflect current dollars are shown in Table 1.

Similar values are given in Ref. (2), Vol. I, Figure 10, p. 88. These values, corrected to current dollars, and the (lb BOD per day) basis are also listed in Table 1. The only serious discrepancy between the values from the two sources is for SRTF plants at 0.1 MGD flow.

### TABLE I

### ANNUAL OPERATING COSTS
**$/lb BOD Treated per Day**
**(in current dollars) at Assumed Flow (MGD)**

| Flow (MGD) | | 0.1 | 1 | 10 | 100 |
|---|---|---|---|---|---|
| **Process** | | | | | |
| AS – | Ref (3) | 31.02 | 15.40 | 8.48 | 5.66 |
| | Ref (2) | 35.39 | 13.92 | 8.02 | 5.43 |
| SRTF | Ref (3) | 22.81 | 9.11 | 4.37 | |
| | Ref (2) | 47.45 | 7.02 | 3.38 | |
| HRTF | Ref (3) | 26.64 | 8.93 | 3.85 | |
| | Ref (2) | 26.51 | 8.95 | 4.97 | |

## C. Operating Cost as a Percentage of Capital Cost

Combining the data from Figure 1 and Table I allows expression of the annual operating cost as a percentage of capital cost. Table II lists these percentages.

## TABLE II

## ANNUAL OPERATING COSTS AS A PERCENTAGE OF CAPITAL COSTS

### At Assumed Flows (MGD)

| Flow (MGD) | 0.1 | 1.0 | 10 | 100 |
|---|---|---|---|---|
| **Process** | | | | |
| AS | 6.1 | 6.1 | 7.1 | 9.8 |
| SRTF | 5.0 | 4.2 | 4.2 | – |
| HRTF | 5.8 | 4.0 | 3.6 | – |

D. Estimating Treatment Costs

Total treatment costs can be estimated using Eq. (1b), Figure 1 and Table I. Suppose, for example, we want to estimate cost of secondary treatment by the activated sludge process for a town of 10,000 people.

$V$ = 10,000 people x 100 gal/person or 1 MGD
$L$ = 250 ppm BOD
$L_o$ = 38 ppm BOD (85% of 250)

Values for $\beta$ for durations of 20, 25 and 30 years and interest rates of 6-9% are shown in Table III.

## TABLE III

## ANNUAL COST OF CAPITAL RECOVERY AND INTEREST

| | | Interest Rate | | | |
|---|---|---|---|---|---|
| | | 6% | 7% | 8% | 9% |
| Duration | 20 years | 0.0873 | 0.0945 | 0.102 | 0.110 |
| | 25 | 0.0783 | 0.0860 | 0.0938 | 0.102 |
| | 30 | 0.0728 | 0.0807 | 0.0889 | 0.0975 |

The value of y depends on the amount of Federal and State aid for which the project is eligible. Municipal sewage treatment facilities in Vermont are generally eligible for Federal grants of up to 55%. The percentage of State aid depends on the financial conditions of the municipality under the equalization provision. For example, if Federal aid amounts to 55% in a specific case, and State aid to 20%, the relevant value of y is

$$y = 1 - 0.55 - 0.20 = 0.25$$

Assume for our example that state and federal grants for construction amount to 75% of the capital cost ($y = 0.25$) and that the remaining capital requirement is borrowed for 20 years at 8% interest.* Therefore, from Table III, $\beta = 0.102$. From Figure 1, $C_c = \$250$/lb BOD per day (Curve 2) and from Table I, $C_o = \$15.40$/lb BOD per day. Note that the cost values are on a basis of BOD *treated* rather than removed. Therefore, $L_o$ in Eq. (1b) must be set to zero, even though the actual effluent from the plant is 38 ppm. Substituting these values into Eq. (1b) yields

$$\begin{aligned} T &= [(0.102)(0.25)(250) + 15.40]\,(8.33)(1)(250) \\ &= [6.38 + 15.40]\,(2083) \\ &= \$45{,}300/\text{year} \end{aligned} \tag{8}$$

Figure 2 shows plots of estimated overall annual treatment costs for the cases of no subsidy on invested capital ($y = 1.00$) and of 75% subsidy on invested capital ($y = 0.25$). Capital amortization at 8% over 20 years is assumed. The upper line in each band shows costs associated with the activated sludge process; the lower line represents both trickling filter processes.

### E. Comparison of Treatment Cost with Industrial Sewer Charges

Maystre and Geyer(4) surveyed 221 cities in 1969 to determine how many cities imposed industrial waste charges and how these charges are determined. Some cities charge on a "lb pollutant treated" basis, usually when some limit on waste concentration is exceeded, and the reported per pound charges should show the average or marginal cost of treatment.

Table III lists data for those cities for which the per pound charge was reported. In the last column of Table IV, all charges are expressed per pound BOD to allow comparison with the estimates generated in earlier sections of this memorandum. This was done by adding together the reported BOD and SS charges since the concentrations in normal sewage are about equal. In the case of Danville, Ill., the additive volume charge was incorporated by dividing the volume charge by 2.083 lb BOD/1000 gal sewage, and adding to the other charges.

Figure 3 shows the waste charges compared to the treatment costs estimated earlier. The estimates were computed by dividing the values shown in Figure 2 by the number of pounds of BOD treated per year (equal to 8.33 (V) (250) (365). The reported waste charges are in general agreement with the estimated treatment costs. The scatter reflects differences in operating efficiency as well as local policy with regard to charging industry.

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* We recognize that Federal grant provisions and the State's matching grants and equalization provisions could cause considerable variation around a 70-90 percent range.

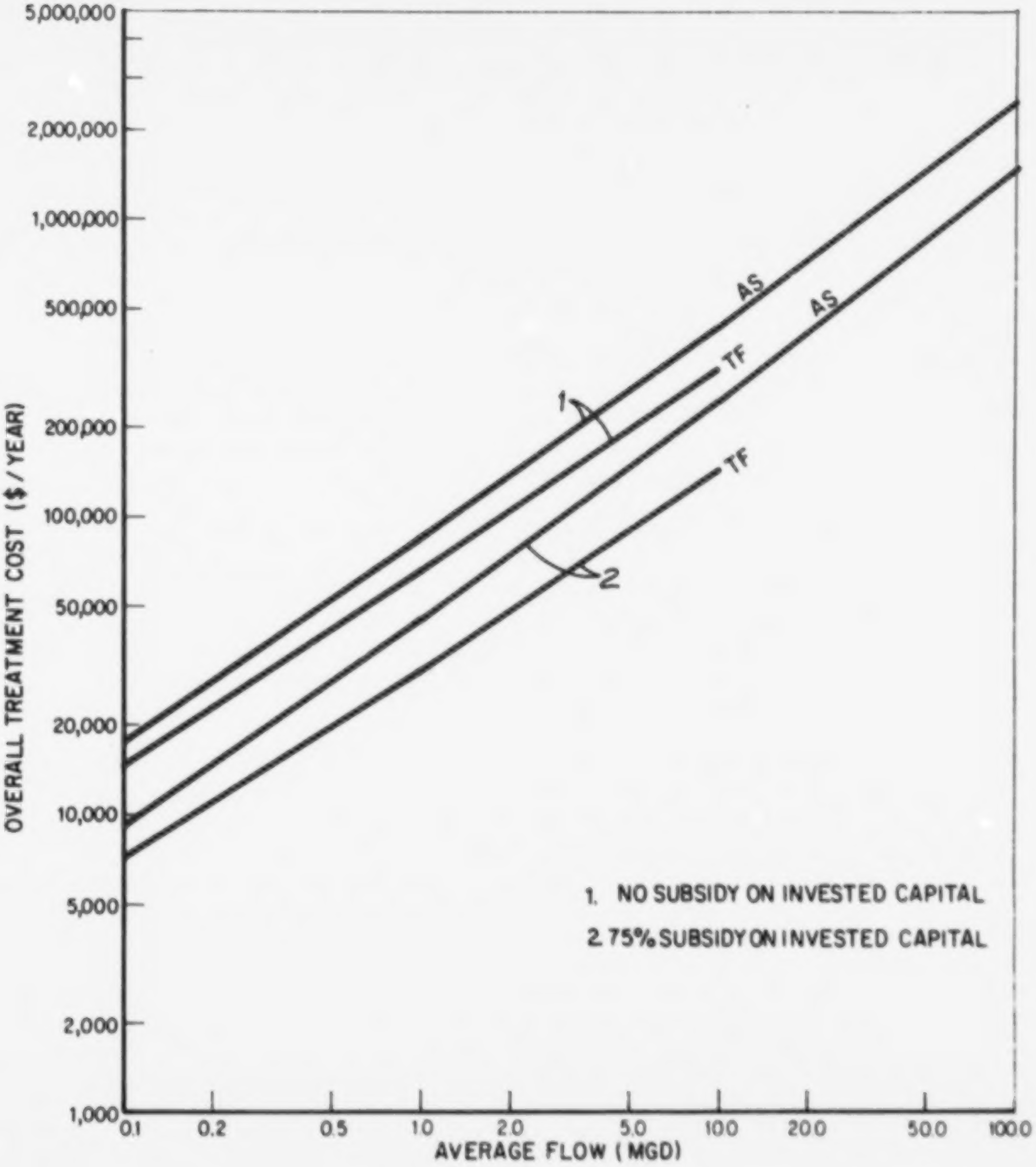

Figure 2 Overall Treatment Cost

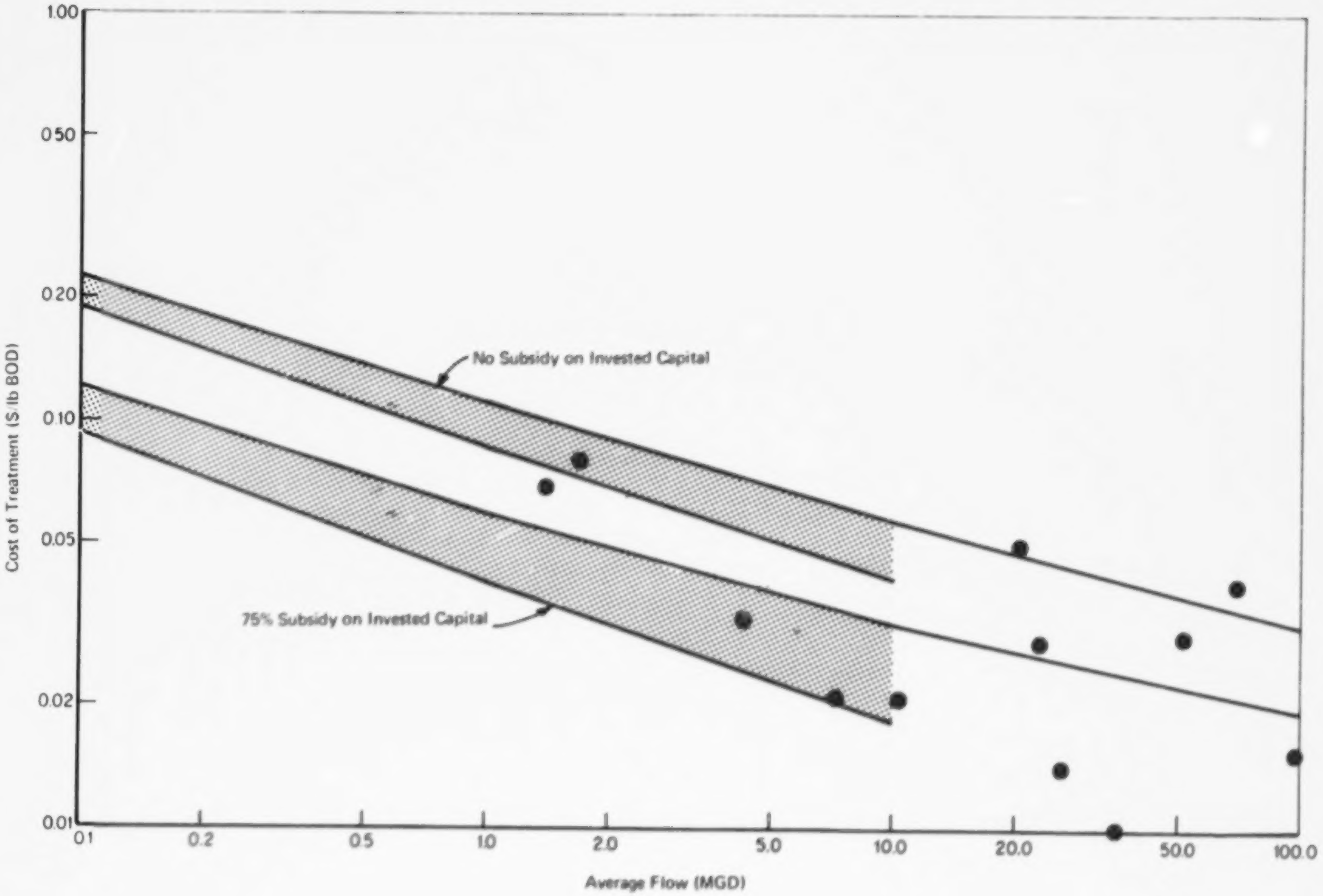

FIGURE 3 COST OF TREATMENT AND INDUSTRIAL CHARGES

## TABLE IV

## INDUSTRIAL WASTE CHARGES

| Town | 1960 Population | $/lb BOD | $/lb SS | $/1000 Gal | $/lb BOD |
|---|---|---|---|---|---|
| Denver, Col. | 520,000 | 0.0147 | 0.0153 | – | 0.0300 |
| Danville, Ill. | 43,200 | 0.0123 | 0.0138 | 0.157 | 0.0336 |
| Grand Rapids, Mich. | 203,000 | 0.0300 | 0.0200 | – | 0.0500 |
| St. Louis, Mo. (1 of 2) | 710,000 | 0.0214 | 0.0190 | – | 0.0404 |
| Springfield, Mo. | 103,500 | 0.0090 | 0.0120 | – | 0.0210 |
| Charlotte, N.C. | 230,000 | 0.0233 | – | – | 0.0233 |
| Hamilton, O. | 73,000 | 0.0090 | 0.0120 | – | 0.0210 |
| Toledo, O. | 354,000 | 0.0100 | – | – | 0.0100 |
| Greensburg, Pa. | 17,400 | 0.0400 | 0.0400 | – | 0.0800 |
| Warren, Pa. | 14,500 | 0.0344 | 0.0352 | – | 0.0696 |
| Nashville, Tenn. | 261,000 | 0.0087 | 0.0049 | – | 0.0136 |
| Dallas, Tex. | 951,000 | 0.0076 | 0.0076 | – | 0.0152 |

## 2. INDUSTRIAL TREATMENT – DAIRIES AND PULP AND PAPER

Generalization of treatment costs is much more difficult for treatment of industrial wastes than for municipal wastes. The principal reason is the wide variety of wastewaters produced by industry. In addition, the wastewaters produced by individual plants in the same industry vary widely in amount per unit product and concentration because of differences in process streams.

The FWQA has embarked on a program for establishing treatment costs in the major industries. The 1968 *Cost of Clean Water* report(5) includes, as Volume III, cost of treatment surveys of ten major industry sectors. Those industries surveyed are:

1. Blast Furnaces & Steel Mills SIC 3312
2. Motor Vehicles and Parts
3. Paper Mills, except Building SIC 2621
4. Textile Mill Products SIC 2231, 2261, 2262
5. Petroleum Refining SIC 2911
6. Canned and Frozen Fruits & Vegetables SIC 2033, 2037
7. Leather Tanning and Finishing SIC 3111
8. Meat Products SIC 2011, 2013, 2015
9. Dairies SIC 2021, 2022, 2023, 2024, 2026
10. Plastics Materials & Resins SIC 28211-28219

Because of the complexities and variability of the wastes produced, simple correlations of treatment costs do not suffice. In most of the FWQA surveys, each industry is categorized in two ways: older, typical and advanced technology, and small, medium and large size. For each of the nine resulting categories, ranges of values and mean values are given for waste production per unit of product and the costs associated with specific types of treatment. Within a given category, the range of reported values may be very large (up to a factor of ten).

The FWQA surveys of the pulp and paper industry and dairies are particularly relevant to Vermont. The data in these surveys could be summarized in a form similar to Figure I and Table I to provide a basis for estimating treatment costs from plant effluent data or from product output. An additional parameter, describing the general characteristics of the processing technology, would be required, making the estimation of cost somewhat more complicated than in the municipal case.

## A. Pulp and Paper

The survey of the pulp and paper industry treats the sulfate and sulfite processes separately and lists effluent loadings for the following subprocesses:

- wood preparation
- pulping
- pulp screening
- pulp washing
- pulp thickening
- bleaching
- paper making

BOD, pH and wastewater quantities are listed along with suspended, dissolved and total solids.

Capital and operating costs are listed for pretreatment, primary treatment and secondary treatments (activated sludge and aerated lagoons) and for sludge disposal. Finally, capital costs of "typical" integrated treatment processes are listed.

## B. Dairies

The dairy industry survey is broken down into five parts:

- creamery butter
- cheese – natural and processed
- condensed and evaporated milk
- ice cream and frozen desserts
- fluid milk (including cottage cheese)

BOD loads (soap and chemicals, lost product, and by-product) are given, together with the effect of common process alternatives on these loads. Capital and operating costs are given as a function of plant size and state of technology for the commonly used treatment processes of:

- ridge and furrow
- spray irrigation
- aerated lagoon
- trickling filter
- activated sludge

## C. Uncertainty in the Cost Estimates

Estimates of the uncertainties in the waste loadings and treatment costs are not given directly in either of these surveys. Based on the reported variability of waste loadings, it is estimated that the reported general treatment costs might differ by at least a factor of two or three from the actual cost experienced by a specific plant.

## D. Net Treatment Cost

While the gross cost of industrial wastewater treatment is given by Equation 1, the net, out-of-product cost is less than that given by Equation 1 due to the effects of the tax laws.

Depreciation, interest payments and operating costs are legitimate costs of business and hence are deductible from taxable profits. In addition, the investment tax credit effectively reduces the initial investment. These factors are discussed below.

### Investment Tax Credit

Most corporations are allowed to deduct 7% of the cost of qualified investments (such as waste treatment facilities) from their Federal income tax. Provided that the corporation has taxable profits from which to subtract this amount, this credit effectively reduces the capital cost by 7% and has essentially the same effect as the Federal grants made to municipalities. Therefore, the annual cost of treatment, before the other tax credits for depreciation, interest payments and operating costs are factored in, can be computed from Equation (1a) with $y = 0.93$.

$$T' = \beta(0.93)\,C'_c + C'_o \qquad (9)$$

where $\beta$ is the capital amortization factor from Table III.

**Depreciation**

Depreciation of capital equipment can be computed for tax purposes by one of several methods: straight-line, sum of the years digits or twice straight-line declining balance. For simplicity and because different pieces of equipment have different useful lives, we can assume a straight-line depreciation over N years. In this case, the annual depreciation amounts to 1/N th of the capital cost or $1/N\, C_c'$. More complex methods taking into account the actual useful life of each piece of equipment might prove slightly more advantageous to the corporation, but the differences are not important for our purposes.

**Interest Payments**

The average annual interest payment over the N year life of the amortization is approximately equal to

$$I\frac{(N+1)}{2N}$$

as a percentage of the total invested capital.

**Operating Cost**

The annual operating cost is given to be $C_o'$.

**Total Deductible Costs**

The total tax deductible costs are equal to the sum of depreciation, interest payments and operating cost, or

$$D = \frac{1}{N} C_c' + (\frac{N+1}{2N}) I C_c' + C_o' \qquad (10)$$

The tax saving due to these deductions is equal to D times the tax rate. The effective tax rate depends on the State and Federal tax rates $t_s$ and $t_f$ respectively, according to

$$\begin{aligned} t &= t_f + (1-t_f)\, t_s \\ &= t_f + t_s - t_f t_s \end{aligned} \qquad (11)$$

The Vermont State tax on corporate income is 6%. The Federal tax rate is 22% plus 26% surtax on all income over $25,000 per year. The incremental Federal tax rates are therefore either 22% or 48% depending on profit level. Substituting these values into Equation (11) gives:

$t = 0.27$ Profits < $25,000/year
$t = 0.51$ Profits > $25,000/year

**Net Annualized Cost**

Combination of the elements developed in previous paragraphs results in the following expression for net annualized cost of treatment.

$$\begin{aligned} T_n &= \beta(0.93)\, C'_c + C'_o \\ &\quad - [\frac{1}{N} C'_c + (\frac{N+1}{2N})\ I C'_c + C'_o]\ t \end{aligned} \tag{12}$$

Rearranging Equation (12) gives:

$$T_n = C'_c\ [\beta(0.93) - \frac{t}{N} (1 + \frac{(N+1)I}{2})] + C'_o\,(1\text{-}t) \tag{13}$$

The coefficient on net annual operating cost ($C'_o$) depends only on the tax rate and is equal to 0.73 if the annual profit is less than $25,000 per year and 0.49 if the annual profit is greater than $25,000 per year.

The coefficient on capital cost ($C'_o$) depends in complex fashion on

N – the number of years over which the capital is amortized
I – the interest rate
t – the incremental tax rate (either 0.27 or 0.51)

Table V shows values of the coefficient for several values of N, and I and the two values of t.

## TABLE V

## COEFFICIENT ON CAPITAL COST PORTION OF NET ANNUALIZED COST OF TREATMENT

t = 0.27 (Profit less than $25,000 per year)

| Interest rate (%) | 6 | 7 | 8 | 9 |
|---|---|---|---|---|
| Amortization Period (yr) | | | | |
| 10 | 0.090 | 0.095 | 0.100 | 0.105 |
| 20 | 0.059 | 0.064 | 0.070 | 0.088 |
| 30 | 0.050 | 0.056 | 0.063 | 0.065 |

t = 0.51 (Profit greater than $25,000 per year)

| Interest rate (%) | 6 | 7 | 8 | 9 |
|---|---|---|---|---|
| Amortization Period (yr) | | | | |
| 10 | 0.058 | 0.061 | 0.066 | 0.069 |
| 20 | 0.039 | 0.044 | 0.048 | 0.052 |
| 30 | 0.035 | 0.040 | 0.045 | 0.050 |

If we take as a basis a 20 year amortization at 8% interest, the net annual cost of treatment is:

$$T_n = 0.070\, C_c' + 0.73\, C_o' \qquad \text{Profit} < \$25{,}000/\text{year}$$

$$T_n = 0.048\, C_c' + 0.49 \qquad \text{Profit} > \$25{,}000/\text{year}$$

For comparison, the gross annual treatment cost for the same condition is:

$$T = 0.102\, C_c' + C_o'$$

## References

1. K.L. Shah and G.W. Reed, Journal of the Water Pollution Control Federation Vol. 42, No. 5, May 1970, p. 776-793.

2. *Cost of Clean Water 1969*, Vol. I, U.S. Department of the Interior, Jan. 10, 1969.

3. R.L. Michel, A.L. Permoter, and R.C. Palange, Journal of the Water Pollution Control Federation, Vol. 41, No. 3, March 1969, p. 335-354.

4. Y. Maystre and J.C. Geyer, Journal of the Water Pollution Control Federation, Vol. 42, No. 7, July 1970, p. 1277-1291.

5. *Cost of Clean Water 1968*, Vol. III, Parts 1-10, U.S. Department of the Interior, January 1968.

# APPENDIX G

## SELECTED CITATIONS ON OPTIMAL RESOURCE ALLOCATION IN RIVER QUALITY MANAGEMENT

1. The University of Wisconsin, Water Resources Center, "Institutional Design for Water Quality Management: a Case Study of the Wisconsin River Basin."

   The above pertains to a current study which has been partially completed in rough form. Information regarding the allocation model explored was contained in a rough draft of Volume III Section J – The Economic and Fiscal Aspects of a Regional Water Quality Management System, authored by A.H J. Dorcey.

   A water quality model in terms of dissolved oxygen (Streeter Phelps) is used as a basis of a least cost of treatment model with a linear programming approach, to meet a stream standard that has a ten percent chance of being violated by hydrologic variations. The model assigns to each polluter a reduction level in terms of % reduction of pounds BOD in the effluent. From this the allowable number of pounds of BOD is computed. The allowable number of pounds becomes the basis for the agency to issue a "poundage order," and to compute on a standard basis the "annual pure cost" of achieving the poundage order. The total system cost for achieving all poundage orders is then distributed to each polluter in proportion to his total % contribution to the BOD load. The final step in the process is to compute transfer payments, in which certain polluters are required to pay a fee, while others receive subsidy payments, depending upon (1) the product of their % order BOD of total system BOD, times the total minimum cost from the allocation model, and (2) the present annual cost of treatment.

   An important rationale for this approach in the Wisconsin study is that a polluter who is not meeting his poundage order has the option of buying additional treatment, or of transferring a payment to another polluter who is not fully utilizing the poundage order assigned to him because of "excess" treatment. Ideally this system encourages the full use of the water resources' waste assimilative capacity, while motivating treatment of wastes at those places in the system where treatment is most economic.

2. Upton, Charles. "Optimal Taxing of Water Pollution," *Water Resources Research*, Vol. 4, No. 5. A mathematical derivation is given for an optimum allocation of the combination of cost of production, cost of treatment, and cost of low flow augmentation, to achieve a minimum level of dissolved oxygen. This is followed by a consideration of whether, and under what theoretical conditions, each of three alternative taxation systems applied to

the optimal allocation, would constitute optimal taxation systems in the sense that the tax will result in each firm using no more and no less than its optimal allocation (i.e., each firm will select a level of treatment consistent with system wide optimal determination of treatment).

3. Upton, Charles, "A Model of Water Quality Management under Uncertainty," *Water Resources Research*, Vol. 6, No. 3. The analysis shows that there is an optimal critical low flow which should be used as a standard in determining optimal levels of treatment to meet a required water quality standard. As the variance of the streamflow increases, the optimal critical value of low flow is seen to decrease.

4. Hass, Jerome E., "Optimal Taxing for the Abatement of Water Pollution," *Water Resources Research*, Vol. 6, No. 2. Application of the Danzig-Wolfe non-linear decomposition algorithm to determine the optimal treatment configuration for meeting water quality standards and for determining the optimal pollution taxes when the central authority does not know treatment costs. The method is demonstrated with application to the Miami River in Ohio.

5. Kneese and Bower, *Managing Water Quality: Economics, Technology, Institutions*, p. 158. A linear programming model that minimizes the system wide cost of attaining a required minimum dissolved oxygen in the Delaware Estuary system.

6. Johnson, Edwin L., "A Study in the Economics of Water Quality Management," *Water Resources Research*, Vol. 3, No. 2. A comparison of several effluent charge systems in the Delaware Estuary, with a theoretical least cost system for attainment of minimum dissolved oxygen.

7. Revelle, Loucks and Lynn, "Linear Programming Applied to Water Quality Management, *Water Resources Research*, Vol. 4, No. 1. A method of solving for required efficiencies of treatment plants in a river network that will assure attainment of specified dissolved oxygen levels at least total cost.

8. Revelle, Dietrich, and Stensel, "Commentary – The Improvement of Water Quality under a Financial Constraint," *Water Resources Research*, Vol. 5, No. 2. An extension of concepts presented in a previous paper by Revelle, Loucks, and Lynn under a constraint that the cost for construction is limited, and that the objective is not to maximize the lowest dissolved oxygen in the river system.

9. Sobel, Matthew J., "Water Quality Improvement Programming Problems," *Water Resources Research*, Vol. 1, No. 4. Application of linear and integer programming to maximize the ratio of benefits to costs in a water quality improvement program.

10. Whipple, William Jr., "Economic Basis for Effluent Charges and Subsidies," *Water Resources Research*, Vol. 2, No. 1. Discussion of a system wide least net cost approach to distributing costs of pollution between those who pollute and those who benefit from pollution abatement.

11. Dysart and Hines, "Development and Application of a Rational Water Quality Planning Model," Water Resources Center, Georgia Institute of Technology, Jan. 1969. Application of dynamic programming to the Chattahoochee River Basin System in which thermal discharges are included, in a model that allocates optimal levels of the use of the stream capacity to assimilate organic and thermal loadings. This paper includes an extensive review of other literature on the subject.

12. Bramhill and Mill, "Alternative Methods of Improving Stream Quality: An Economic and Policy Analysis," *Water Resources Research*, Vol. 2, No. 3. Application of a steepest ascent search algorithm, to solve for optimal levels of treatment required to maintain a given stream quality.

13. Liebman, Jon C., "The Optimal Allocation of Stream Dissolved Oxygen Resources," Cornell University Water Resources Center Publication, Sept. 1965, and *Water Resources Research*, Vol. 2, No. 3. Two different approaches to a dynamic programming formulation of the problem of determining the optimal level of treatment to assure a minimum dissolved oxygen level are explored.

14. Anderson and Day, "Regional Management of Water Quality – A Systems Approach," Journal of the Water Pollution Control Federation, October 1968. The Miami River Basin in Ohio is taken as a case study example, in which the cost of achieving a minimum level of water quality as determined by a stream standard is minimized using a linear programming model based upon the Streeter Phelps equations for BOD. The solution is in terms of degree of treatment required.

15. Kerri, Kenneth, "An Economic Approach to Water Quality Control," Journal of the Water Pollution Control Federation, December 1966. Using a non-linear programming approach minimum cost solutions were derived to meet specified dissolved oxygen requirements in the Willamette River Basin south of Portland, Oregon. The Streeter Phelps equations were used as the basis of forecasting dissolved oxygen levels, and the total cost of treatment was minimized.

# APPENDIX H

## TITLE 10, VERMONT STATUTES ANNOTATED

### Chapter 33. Water Pollution Control
### Subchapter 1. Water Pollution Control

### § 901. DEFINITIONS

Whenever used or referred to in this chapter, unless a different meaning clearly appears from the context:

(1) "Board" means the Vermont water resources board;

(2) "Department" means the department of water resources;

(3) "Discharge" means the placing, depositing or emission of any wastes, directly or indirectly, into the waters of the state;

(4) "Person" means an individual, partnership, public or private corporation, municipality, institution or agency of the state, and includes any officer or governing or managing body of a partnership, association, firm or corporation;

(5) "Public interest" means that which shall be for the greatest benefit to the people of the state as determined by the standards set forth in subsection (e) of section 903 of this title;

(6) "Waste" means effluent, sewage or any substance or material, liquid, gaseous, solid or radioactive, including heated liquids, whether or not harmful or deleterious to waters;

(7) "Waters" shall include all rivers, streams, creeks, brooks, reservoirs, ponds, lakes, springs and all bodies of surface waters, artificial or natural, which are contained within, flow through or border upon the state or any portion thereof – 1969, No. 252 (Adj. Sess.), § 1.

## § 902. CLASSIFICATION OF WATERS

The state of Vermont hereby adopts, for the purposes of classifying its waters, the following classes and definitions thereof:

| | |
|---|---|
| Class A. | Suitable for public water supply with disinfection when necessary. Character uniformly excellent. |
| Class B. | Suitable for bathing and recreation, irrigation and agricultural uses; good fish habitat; good aesthetic value; acceptable for public water supply with filtration and disinfection. |
| Class C. | Suitable for recreational boating, irrigation of crops not used for consumption without cooking; habitat for wild life and for common food and game fishes indigenous to the region; and such industrial uses as are consistent with other class "C" uses. |
| Class D. | Suitable for supporting aerobic aquatic life, for power, navigation and certain industrial process needs consistent with other class D uses and for restricted zones of water to assimilate appropriately treated wastes – Amended 1961, No. 101, 1964, No. 37 (Sp. Sess.), § 3; 1967, No. 181, § 1, eff. April 17, 1967. |

1967 amendment. "Class D" redefined.

1964 amendment. Class A: Inserted "with disinfection when necessary."

Class D: Added sentence providing for character free of foaming, heavy discoloration or deposits of settleable material.

1961 amendment. Added at end of Class C; "and such industrial uses as are consistent with other class '(C)' uses."

Purposes of 1964, No. 37 (Sp. Sess.). See § 901 note of this title.

## § 903. CLASSIFICATION OF WATERS DESIGNATED, RECLASSIFICATION

(a) The waters of all lakes, ponds and reservoirs, natural or artificial, used for public water supply and all waters flowing into such lakes, ponds and reservoirs are hereby designated Class A waters and shall be maintained as such unless reclassified.

(b) The remaining waters except as otherwise classified by the board prior to the effective date of this section are hereby designated Class B waters and shall be maintained as such unless reclassified.

(c) On its own motion, or upon petition by a municipality or by thirty or more persons in interest alleging that it or they suffer injustice or inequity as a result of the classification of any waters established by the board or this section, the board shall hold a public hearing convenient to the waters and area concerned and shall give all interested parties an opportunity to appear and be heard. If upon consideration of all the evidence submitted, the board finds that the established classification is contrary to the public interest, it may, by order, reclassify all or any portion of such waters to a higher or lower classification. If, pursuant to the above procedure, the board finds that it is in the public interest to change the classification of any pond, lake or reservoir designated as Class A waters by subsection (a) of this section, it shall so advise and consult with the department of health and shall provide for in its reclassification order a reasonable and sufficient period of time before the order becomes effective during which time, any municipalities or persons whose water supply is affected shall construct filtration and disinfection facilities or convert to a new source of water supply. Any person aggrieved by an order of the board issued pursuant to this section may appeal as provided in section 915 of this title.

(d) The board shall determine what degree of water quality and classification should be obtained and maintained for those waters not heretofore classified by it following the procedures in sections 904-908 of this title. Such waters shall be classified in the public interest.

(e) In determining the question of public interest, the board shall give due consideration to:

(1) existing and obtainable water qualities;

(2) existing and potential or anticipated water uses;

(3) natural sources of pollution;

(4) public and private pollution sources and technological means of abating the same;

(5) need for and potential use of mixing zones;

(6) existing and potential use of waters for public water supply, recreational, agricultural, industrial and other legitimate purposes;

(7) suitability of waters as habitat for fish, aquatic life and wildlife;

(8) need for and use of minimum stream flow requirements;

(9) federal requirements for classification and management of waters;

(10) municipal, regional and state plans; and

(11) any other factors relevant to determine the maximum beneficial use and enjoyment of waters – No. 252 (Adj. Sess.) § 2., 1969.

## § 904. CLASSIFICATION OF WATERS BY BOARD; AID

In classifying the waters of the state, the board is authorized to call upon any state department or agency for any pertinent information, other than information of a confidential nature, which the department or agency has or could obtain easily in the course of its work – 1969, No. 252 (Adj. Sess.), § 3.

## § 905. CLASSIFICATION HEARINGS

The board may hold such public hearings as it deems necessary, and shall give notice thereof by publication or otherwise to municipal officials, to organizations and to persons, individual or corporate, having an interest in the use of the particular waters to be classified. The board may require that any or all testimony or evidence presented at a hearing be given under oath. Source, 1949, No. 148, § 6.

## § 906. CLASSIFICATION ADVISORY COUNCIL

The board shall request the governor to appoint, from within the drainage area of the waters under consideration for classification, three residents, or one for each ten thousand inhabitants, whichever gives the greater number, at least one of whom shall be a representative of industry, and the governor shall assign representatives, one each from the department of health, fish and game department, forests and parks department, recreation board, development department and public service board, or a representative from such of the departments named as shall to the governor seem necessary, such persons to act as a consulting council to assist the board in its determination of classification of such waters or parts thereof. The appointed members of each council shall be paid $15.00 per day and necessary expenses for each day necessarily spent in performance of their duties. The time and expenses of the assigned members of the council shall be paid by the departments or agencies which they represent – 1969, No. 252 (Adj. Sess.), § 4.

### § 907. OBJECTION BY RESIDENTS; NOTICE OF PROPOSED CLASSIFICATION

Using whatever means it deems proper, the board shall give notice of the proposed classification to the people resident in the drainage area of the waters concerned and shall arrange a time and place for objections to be heard. The board shall consider objections to its proposed classification and shall reclassify any part or all of the waters on a sufficient showing that its proposed classification is contrary to the public interest – 1969, No. 252 (Adj. Sess.), § 5.

### § 908. MANAGEMENT OF WATERS AFTER CLASSIFICATION, ENFORCEMENT

After the classification of any waters has been determined by order of the board, such waters shall be managed under the supervision of the board in order to obtain and maintain the classification established within the periods specified in the order. The board may enforce a classification order against any person named therein and affected thereby who, with notice of the classification proceedings and order, has failed to comply with such order by suit in equity brought before the chancery court of the county wherein the affected waters are located – 1969, No. 252 (Adj. Sess.), § 6.

### § 909. PROHIBITIONS

(a) No person, without written authorization of the board, shall discharge into the waters of the state any waste which by itself or in combination with the wastes of other sources reduces the quality of the receiving wastes below the classification established for them. This subsection shall not prohibit the proper application of fertilizer to fields and crops. On July 1, 1971, this subsection shall expire and be deemed repealed.

(b) On and after July 1, 1971, no person shall discharge any wastes, substance or material into waters of the state without first obtaining a permit for such discharge from the department. This subsection shall not prohibit the proper application of fertilizer to fields and crops – 1969, No. 252 (Adj. Sess.) § 7.

## § 910a. DISCHARGE REPORTS REQUIRED

Any person who is discharging treated or untreated waste into waters of the state on a regular, intermittent or continuous basis prior to the effective date of this section and intends to continue such discharges on or after July 1, 1971, shall file a written report of such discharges with the department by September 1, 1970. Such report shall specify the location, nature, volume and frequency of such discharges. The department may require such person to furnish such additional information it deems necessary to evaluate the effect of such discharges upon the receiving waters – 1969, No. 252 (Adj. Sess.), § 10.

## § 911a. DISCHARGE PERMITS

(a) Any person intending to discharge waste into the waters of the state on and after July 1, 1971, shall make application to the department for a discharge permit. Application shall be made on a form prescribed by the department and shall contain such information as the department may therein require. An applicant shall pay to the department at the time of submitting his application such amount as the board shall by rule determine reasonable to defray the expenses of reviewing and evaluating an application.

(b) The department shall consider each application and shall grant or deny the requested permit within sixty days from the date of receipt of the application. The department may require the applicant to submit any additional information which it considers necessary and may refuse to grant a permit until such time as the information is furnished and evaluated.

(c) If the department finds that the proposed discharge will reduce the quality of the receiving waters below the classification established for them, it shall deny the application and refuse to issue a permit. If the department finds that the proposed discharge will not reduce the quality of the receiving waters below the classification established for them, it shall issue a discharge permit.

(d) A discharge permit shall:

(1) specify the manner, nature, volume and frequency of the discharge permitted;

(2) require proper operation and maintenance of any pollution abatement facility necessary in the treatment or processing of the waste by qualified personnel in accordance with standards established by the board;

(3) contain such additional conditions, requirements and restrictions as the department deems necessary to preserve and protect the quality of the receiving waters; and

(4) be valid for the period of time specified therein.

(e) A discharge permit may be renewed from time to time upon application to the department. No renewal permit shall be issued if the department finds that the proposed discharge will reduce the quality of the receiving waters below the classification established for them – 1969, No. 252. (Adj. Sess.), § 11.

## § 912a. TEMPORARY POLLUTION PERMITS

(a) A person who does not qualify or has been denied a waste discharge permit under section 911a of this title may apply to the department for a temporary pollution permit. Application shall be made on a form prescribed by the department and shall contain such information as the department may therein require. Such person shall pay to the department at the time of submitting the application such amount as the board shall by rule determine reasonable to defray the expenses of reviewing and evaluating each application. The department may require such person to submit any additional information it considers necessary for proper evaluation.

(b) Using whatever means it deems proper, the department shall give notice to the people resident in the drainage area of the receiving waters for the proposed discharge of the time in which they may present written objections to the proposed discharge.

(c) After consideration of the application, any additional information furnished and all written objections submitted, the department shall grant or deny a temporary pollution permit. No such permit shall be granted by the department unless it affirmatively finds:

(1) the proposed discharge does not qualify for a discharge permit;

(2) the applicant is constructing, installing or placing into operation or has submitted plans and reasonable schedules for the construction, installation or operation of an approved pollution abatement facility or alternate waste disposal system, or that the applicant has a waste for which no feasible and acceptable method of treatment or disposal is known or recognized but he is making a bona fide effort through research and other means to discover and implement such a method.

(3) the applicant needs permission to pollute the waters of the state for a period of time after July 1, 1971 necessary to complete research, planning, construction, installation or the operation of an approved and acceptable pollution abatement facility or alternate waste disposal system;

(4) there is no present, reasonable, alternative means of disposing of the waste other than by discharging it into the waters of the state;

(5) the denial of a temporary pollution permit would work an extreme hardship upon the applicant;

(6) the granting of a temporary pollution permit will result in some public benefit;

(7) the discharge will not be unreasonably destructive to the quality of the receiving waters.

(d) Any temporary pollution permit issued shall:

(1) specify the manner, nature, volume and frequency of the discharge permitted;

(2) require the proper operation and maintenance of any interim or temporary pollution abatement facility or system required by the department as a condition of the permit;

(3) require the permit holder to maintain such monitoring equipment and make and file such records and reports as the department deems necessary to insure compliance with the terms of the permit and evaluate the effect of the discharge upon the receiving waters;

(4) be valid only for the period of time necessary for the permit holder to place into operation the facility, system or method contemplated in his application as determined by the department;

(5) require as a condition of the permit the payment of periodic pollution charges in accordance with pollution charge rates established by the board pursuant to subsection (e) of this section; and

(6) shall contain such other requirements, restrictions and conditions which the department deems necessary and desirable to protect the quality of the receiving waters and promote the public interest.

(e) Pollution charges: By January 1, 1971, the board shall fix and establish reasonable and just pollution charge rates for computing the amounts to be paid by temporary pollution permit holders pursuant to subsection (d) of this section. The board is authorized to revise such charge rates from time to time thereafter.

(1) Purpose: It is expressly recognized that the authorized discharge of certain wastes which will reduce the quality of receiving waters below the established classification represents an expropriation of a valuable public natural resource for private or limited use and that such discharges are permitted under this subchapter for economic reasons in the public interest of providing time during which the degrading effects of such discharges can be abated. The imposition of pollution charges shall have the principal purpose of providing the economic incentive for temporary pollution permit holders to reduce the volume and degrading quality of their discharges during the limited period when such discharges are authorized, thereby raising the quality of the waters in the state. Such charges shall be for the further purpose of protecting the health, welfare and safety of the general public, protecting, preserving, and benefiting navigation upon the waters of the state and protecting the general public interest in such waters including recreational and aesthetic interest. The charges are not imposed for revenue purposes and any income received by the state under this section shall be used solely for purposes of water quality management and pollution control.

(2) How established: A pollution charge is the price to be paid per unit of waste discharged into waters of the state. The charge may vary among different types or classes of wastes to account for variations in the degrading effects of various wastes. The charges may also vary to account for variations in the water quality standards of different classes and the hydrologic conditions of different receiving waters. In establishing the charges the board shall attempt to approximate in economic terms the damage done to other users of the waters, both private users and the general public, caused by the degrading effect of various types of waste in varying volumes and frequencies of discharge upon water qualities of the different classes of waters. In determining relative degrading effect, the board may employ any scientific or technical criteria or parameters such as biochemical oxygen demand and suspended solids and may express the unit charge in terms of such standards of measurement — 1969, No. 252 (Adj. Sess.), § 12.

## § 913a. REVOCATION OF PERMITS

The department may revoke any permit issued by it pursuant to this subchapter if it finds that the permit holder submitted false or inadequate information in his application or has violated any requirement, restriction or condition of the permit issued. Revocation shall be effective upon actual notice thereof to the permit holder – 1969, No. 252 (Adj. Sess.), § 13.

## § 914a. APPEALS TO BOARD

Any person or party in interest aggrieved by an act or decision of the department pursuant to this subchapter may appeal such act or decision to the board within thirty days from the date thereof. The board shall hold a hearing at which all persons and parties in interest may appear and be heard and shall issue an order affirming, reversing or modifying the act or decision of the department within 10 days following the conclusion of the hearing. Such order shall be binding upon the department. An appeal filed pursuant to this section shall not stay the effectiveness of any act or decision of the department pending determination by the board – 1969, No. 252 (Adj. Sess.), § 14.

## § 915. APPEALS TO COURT OF CHANCERY

Any person or party in interest aggrieved by any order or decision of the board pursuant to this subchapter may appeal such order or decision within thirty days from the date thereof to the court of chancery of any county in which the receiving waters are located. All appeals taken pursuant to this section shall be based solely upon the record of the proceedings before the board. The court shall determine whether the board acted arbitrarily, unreasonably or contrary to law and shall issue its findings and order accordingly. An appeal filed pursuant to this section shall not stay the effectiveness of any order or decision of the board pending determination by the court unless the court so orders. Appeals from the decision of the court of chancery may be taken as provided in Title 12 – 1969, No. 252 (Adj. Sess.), § 8.

## § 916a. ANTICIPATED DISCHARGE

If the department finds that any person is constructing, installing, operating or maintaining any facility or condition which reasonably can be expected to create or cause a discharge to waters in violation of this subchapter, it may issue an order directing such person to take the necessary steps to correct such potential source of discharge. Any person who receives an order pursuant to this section may appeal to the board as provided in section 914a of this title – 1969, No. 252 (Adj. Sess.), § 15.

## § 917a. ENFORCEMENT

Notwithstanding any other provision or procedure set forth in this subchapter if the board finds that any person has discharged or is discharging any waste in violation of this subchapter or that any person has failed to comply with any provision of any order or permit issued in accordance with this subchapter, it may bring suit in equity in the Washington county court of chancery or in any county where the discharge or noncompliance has occurred to enjoin such discharge and obtain compliance. Such suit shall be brought by the attorney general in the name of the state. The court of chancery may issue a temporary injunction or order in any such proceedings and may exercise all the plenary powers available to such court in addition to the power to:

(1) enjoin future discharges;

(2) order the design, construction, installation or operation of pollution abatement facilities or alternate waste disposal systems;

(3) order the removal of all wastes discharged and the restoration of water quality;

(4) fix and order compensation for any public property destroyed, damaged or injured, and

(5) assess and award punitive damages – 1969, No. 252 (Adj. Sess.) § 16.

## § 918. PENALTY

Any person who violates any provision of this subchapter or who fails, neglects or refuses to obey or comply with any order or the terms of any permit issued in accordance with this subchapter, shall be fined not more than $10,000.00 or be imprisoned not more than five years, or both. Each violation shall be a separate and distinct offense and, in the case of a continuing violation, each day's continuance thereof shall be deemed a separate and distinct offense – 1969, No. 252 (Adj. Sess.), § 9.

## § 919. CONSTRUCTION

Nothing contained in this subchapter shall be construed to prohibit or require a permit for the proper use of waters for customary sport and recreational purposes such as fishing, swimming and boating if the classification of the water permits such usage. In the event of an irreconcilable conflict between the provisions of this subchapter and chapter 25 of Title 3, the provisions of this subchapter shall supersede and prevail. Nothing in this subchapter shall be construed to affect, impair or abridge the right of riparian or littoral owners or others to sue for damages or injunctions or exercise any other common law or statutory remedy to abate and recover damages for water pollution. If a permit holder is required to pay such damages by judgment or order of a court, the amount of such damages shall be a credit against any pollution charges due under this subchapter. Any permit granted under this subchapter shall not be construed as a vested right and shall be subject to continuing regulations and control by the state – 1969, No. 252 (Adj. Sess.), § 17.

## § 920. MUNICIPAL SEWAGE TREATMENT PLANTS

If, after public hearing, the board finds that any municipality is discharging untreated or improperly treated sewage into waters of the state or that conditions exist in any municipality or combination of municipalities which cause or threaten to cause a reduction in the quality of ground or surface waters and that such discharge or condition can most effectively be corrected or abated by the construction and installation of a sewage collection and treatment system, it may after giving due regard to regional development factors order the municipality or combination of municipalities to provide the facilities necessary to correct or abate the discharge or condition. Such order shall include a reasonable time schedule for action by the municipality or municipalities to place such facilities into operation. This section shall not be construed to abridge any duty or remedy created by this subchapter – 1969, No. 252 (Adj. Sess.), § 22.

## RATIFICATION

(a) The water use classes and standards of quality and technical guidelines for intrastate waters adopted by the board on March 10, 1967 and the general policy, water use classes and standards of quality for interstate waters adopted by the board on May 29, 1967 are ratified. The board may amend, revise, repeal and supplement these regulations by exercise of its regulation-making authority in order to provide and maintain current scientific and technical criteria by which to distinguish and determine the classes of water established by this subchapter.

(b) All water classification orders, as amended, issued by the board prior to January 1, 1970 are ratified – 1969, No. 252 (Adj. Sess.), § 19.

## REVOCATION OF PRIOR PERMITS

(a) All discharges and pollution permits heretofore issued by the boards are revoked effective July 1, 1971, except permits issued following formal public hearings and in which the board has expressly retained continuing regulatory jurisdiction over the discharge. Such permits so issued and the holders thereof are exempt from the application of the first sentence of this subsection but shall be subject to all other provisions of this act and the subchapter of which it is a part.

(b) Nothing in subsection (a) of this section shall lessen the authority of the board to strengthen or make more effective final orders of permit by changes therein nor shall anything in subsection (a) of this section exempt from revocation, other than the revocation requirements contained in such subsection, any permits issued following formal public hearings and in which the board has expressly retained continuing regulatory jurisdiction over the discharge – 1969, No. 252 (Adj. Sess.), § 20.

## EFFECTIVE DATE

Section 2 shall take effect on July 1, 1971. All other sections shall take effect from passage – 1969, No. 252 (Adj. Sess.), § 21.

## Subchapter 2. Mill Refuse

### § 951. DEPOSIT OF SAWMILL WASTE IN WATERS

(a) It shall be unlawful for a person to deposit edgings, slabs, sawdust, shavings or any other sawmill refuse in the waters of any stream, pond reservoir, or lake in this state or on the shores or banks thereof in such a manner as to be subject to being washed in the main stream or body of water under normal high water conditions.

(b) A person who violates the provisions of subsection (a) shall be fined no more than $100.00 for each offense – Amended 1963, No. 224, 1967, No. 112.

# APPENDIX I

## SUMMARY OF WATER QUALITY STANDARDS

## I. INTRASTATE WATERS

### General

A. Effluent Discharges

When an effluent is permitted to be discharged from an appropriate waste treatment facility, as *approved* by the Vermont Water Resources Board, a zone of mixing will be defined by the Board. This zone is not to be construed as a variance in the Class of water so assigned but only as a zone of water to allow for diffusion of the approved effluent. Class D waters will be assigned only where a higher water use class cannot be attained after all appropriate waste treatment methods are utilized as provided by Vermont Statutes.

B. Appropriate Treatment

Appropriate treatment shall be defined as secondary treatment with disinfection or its industrial waste equivalent as determined by the Vermont Water Resources Board. Lesser degrees of treatment or control may be permitted where it can be demonstrated definitely that attainment of the specified water use class standards of quality can be accomplished.

C. Unusual Pollutants

Water quality standards not specifically described in the descriptive table shall be evaluated on a case-by-case basis by the Vermont Water Resources Board. Such pollutants may include but are not limited to radioactive substances, pesticides, herbicides or algicides.

D. Effluent Restrictions

There shall be no discharge of effluent from any sewage treatment plant or facility into:

1) Class A waters of the State: 10 V.S.A., 903, paragraph 1.

2) Class B lakes or ponds lying within the State's boundaries: 10 V.S.A., 903, paragraph 2, and 10 V.S.A., 901 through 908.

3) Class B streams or rivers from the headwaters down to the point where such properly treated effluent is presently being introduced.

except in cases of extreme need or reasonable necessity, in which cases, tertiary treatment or its equivalent will be required; 10 V.S.A., 901 through 908.

E. Appropriate Disinfection

These terms shall be defined as any process that has equivalent bactericidal effects to that achieved by chlorination with twenty minute detention and at least 0.5 mg/l of chlorine residual in the effluent.

## Technical

A. Hydrology

Standards shall apply to stream conditions existing during critical minimum low flow periods. In the administration of the State's comprehensive water pollution control program, consideration shall be given to providing mechanical means at dams for sustained flow where necessary to eliminate the hazard of water quality degradation during periods of interrupted streamflow.

B. Sampling

1. Dissolved Oxygen
   Class B waters: 7.0 mg/l.

   Class C waters: Not less than 5 mg/l during at least 16 hours of any 24-hour period nor less than 4 mg/l at any time.

   Class D waters: Not less than 2 mg/l during at least 16 hours of any 24-hour period nor less than 1 mg/l at any time.

2. Coliform Bacteria
   Class A waters: Not to exceed a median value of 100 coliform organisms per 100 ml for a minimum of five samples collected during any 30-day period. Individual daily value shall not exceed 500 coliform organisms.

   Class B waters: Not to exceed a median value of 500 coliform organisms per 100 ml for a minimum of five samples collected during any 30-day period. Individual daily value shall not exceed 2500 coliform organisms.

Class C waters: All domestic sewage effluents must be disinfected. Other waste effluents not specifically of a domestic origin but containing organisms that could influence public health conditions must also be disinfected when so directed by the Board. Limits on coliform organisms shall be a median of 5000 per 100 ml for a minimum of five samples collected during any dry weather flow period.

Class D waters: All domestic sewage effluents must be disinfected. Coliform counts permissible in these waters will be that value obtained after the effluent has received appropriate disinfection.

C. Chemical Constituents

Waters shall be free from chemical constituents in concentrations or combinations which would be harmful to human, animal, or aquatic life for the appropriate water use class. In areas where fisheries are the governing consideration and approved limits have not been established, bioassays shall be performed as required by the Vermont Water Resources Board. For public drinking water supplies the limits prescribed by the United States Public Health Service may be used where not superseded by more stringent State Health Department requirements.

D. Temperature

Class C waters: Thermal pollution will be evaluated on an individual discharge basis. Treatment of thermal discharges must be effected so that the resulting stream temperatures follow the normal diurnal fluctuation.

Class D waters: Thermal pollution will be evaluated on an individual discharge basis. In no case should a maximum temperature of 90° be reached for more than six hours of each 24-hour period. Treatment of the thermal discharges should be effected so that the resulting stream temperatures follow the normal diurnal fluctuation.

## TABLE I (a)

## CLASSIFICATION SUMMARIES RELEVANT TO VERMONT
(Classification Summary for Intra State Waters)

| Stream Quality Standard | Quality Factor | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | DO (mg/l) | Sludge and Floating Solids | Color and Turbidity | Coliform(1) | Taste and Odor | pH | Chemicals | Temperature |
| A | (2) | (2) | (2) | $\bar{u} < 100$/ml | (2) | (2) | (2) | (2) |
| B | 7 | (2) | (2) | $\bar{u} < 500$/ml | (2) | (3) | (2) | (2) |
| C | 5 | (4) | (4) | $\bar{u} < 5000$/ml | (4) | 6.0-8.5 | (4) | (5) |
| D | 2 | (4) | (4) | (6) | (4) | 6.0-9.0 | (4) | 90° max |

(1) $\bar{u}$ mean of samples taken.

(2) Natural stream conditions are to prevail.

(3) No reduction; may be increased to 8.0.

(4) Only that contributed by appropriately treated effluent. In the intra-state standard, contiguous water classifications shall not be violated.

(5) Uses assigned to the class shall not be impaired.

(6) Treatment via disinfection only.

## II. INTERSTATE WATERS

1. The New England Interstate Water Pollution Control Commission acting in accordance with Article V of the Compact has reviewed and revised the "Water Use Classes and Standards of Quality for Interstate Waters" in order to assist the states in the administration of more effective and expeditious water pollution control programs in the New England Compact area. The Water Resources Board hereby ratifies the Standards of Quality as revised and adopts them in principle.

2. In the classification of waters due consideration will be given to all factors involved including public health, public enjoyment, propagation and protection of fish and wildlife, and economic and social development. Classifications are not intended to permit indiscriminate waste disposal or to allow minimum efforts of waste treatment under any circumstances.

3. Water Quality control problems not specifically referred to in this document shall be evaluated on a case by case basis by the affected states water pollution control agencies and departments of health.

4. Appropriate treatment shall be defined as secondary treatment with disinfection or its industrial waste equivalent as determined by the signatory state regulatory agency. Lesser degrees of treatment or control will be permitted only where it can be demonstrated that attainment of the specified water use class criteria of quality can be effectuated.

5. In the discharge of effluents to the receiving waters, cognizance shall be given both in time and distance to allow for mixing of effluent and stream. Such distances required for complete mixing shall not affect the water usage Class adopted but shall be defined and controlled by the regulatory authority.

6. Recommendations on other waste parameters will constitute a portion of the continuing effort of the Commission in assisting the states in solving interstate water quality problems. The Commission reserves the right to amend or extend the following recommendations as improved standard methods are developed or revisions consistent with the enhancement of water quality are justified.

**Notes**

1. These Standards do not apply to conditions brought about by natural causes.

2. Class D waters will be assigned only where a higher water use Class cannot be attained after all appropriate water treatment methods are utilized.

3. All sewage treatment plant effluents shall receive disinfection before discharge to the watercourse. The degree of treatment and disinfection shall be as required by the state pollution control agency.

4. Any water falling below the standards of quality for a given Class shall be considered unsatisfactory for the uses indicated for that Class. Waters falling below the standards of quality for Class D shall be considered to be in a nuisance condition.

5. Waters shall be free from chemical constituents in concentrations or combinations which would be harmful to human, animal, or aquatic life for the appropriate, most sensitive and governing water class use. In areas where fisheries are the governing considerations and approved limits have not been established, bioassays including assessment of taste and odor in edible fish shall be performed as required by the appropriate agencies. For public drinking water supplies the limits prescribed by the United States Public Health Service may be used where not superseded by more stringent signatory state requirements.

6. Radioactivity limits to be approved by the appropriate state agency with consideration of possible adverse effects in downstream waters from discharge of radioactive wastes; limits in a particular watershed to be resolved when necessary after consultation between states involved.

7. The temperature increase shall not raise the temperature of the receiving waters above 68°F for waters supporting cold water fisheries and 83°F for waters supporting a warm water fishery. In no case shall the temperature of the receiving water be raised more than 49° F.

8. Sludge deposits, floating solids, oils, grease and scum shall not be allowed except for such small amounts that may result from the discharge of appropriately treated sewage or industrial waste effluents.

9. The minimum average daily flow for seven consecutive days that can be expected to occur once in ten years shall be the minimum flow to which the standards apply.

10. Class B and C waters shall be substantially free of pollutants that:

a) Unduly affect the composition of bottom fauna.
b) Unduly affect the physical or chemical nature of the bottom.
c) Interfere with the propagation of fish.

11. Class A waters reserved for water supply may be subject to restricted use by state and local regulation.

## TABLE I (b)

## CLASSIFICATION SUMMARIES RELEVANT TO VERMONT
(Classification Summary for Inter State Waters)

| Stream Quality Standard | Quality Factor: DO (mg/l) | Sludge and Floating Solids | Color and Turbidity | Coliform(1) | Taste and Odor | pH | Chemicals | Temperature |
|---|---|---|---|---|---|---|---|---|
| A | 75% sat.<br>16 hr<br>5 anytime | (2) | (2) | 0<100/ml<br>$\bar{u}_{10}<500$/ml | (2) | (2) | (3) | (2) |
| B | 75% sat.<br>16 hr.<br>5 anytime | (2) | (4) | $\bar{u}<1000$/ml<br>$\bar{u}_{20}<2400$/ml | (4) | 6.5-8.0 | (3) | (4) |
| C | 5-16 hr.<br>3-24 hr.<br>(except 5 for 24 hr. for cold water fish | (5) | (4) | (4) | (4) | 6.0-8.5 | (3) | (4) |
| D | 2 | (5) | (4) | (4) | (4) | 6.0-9.0 | (3) | 90°max(4) |

(1) $\bar{u}$ mean of samples taken, $\bar{u}_{10}$ mean of highest 10% of samples taken, and $\bar{u}_{20}$ mean of highest 20% of samples taken.
(2) Natural stream conditions are to prevail.
(3) Water must be free of toxic constituents with most sensitive water use governing. Under certain conditions, bio-assays and taste and odor tests are to be performed.
(4) Uses assigned to the class shall not be impaired.
(5) Only that contributed by appropriately treated effluent.